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Spatial Distribution of Radiation from the Beam Line VIII-W 15-Period Wiggler

E. M. Lent

W. C. Dickinson

May 13, 1985



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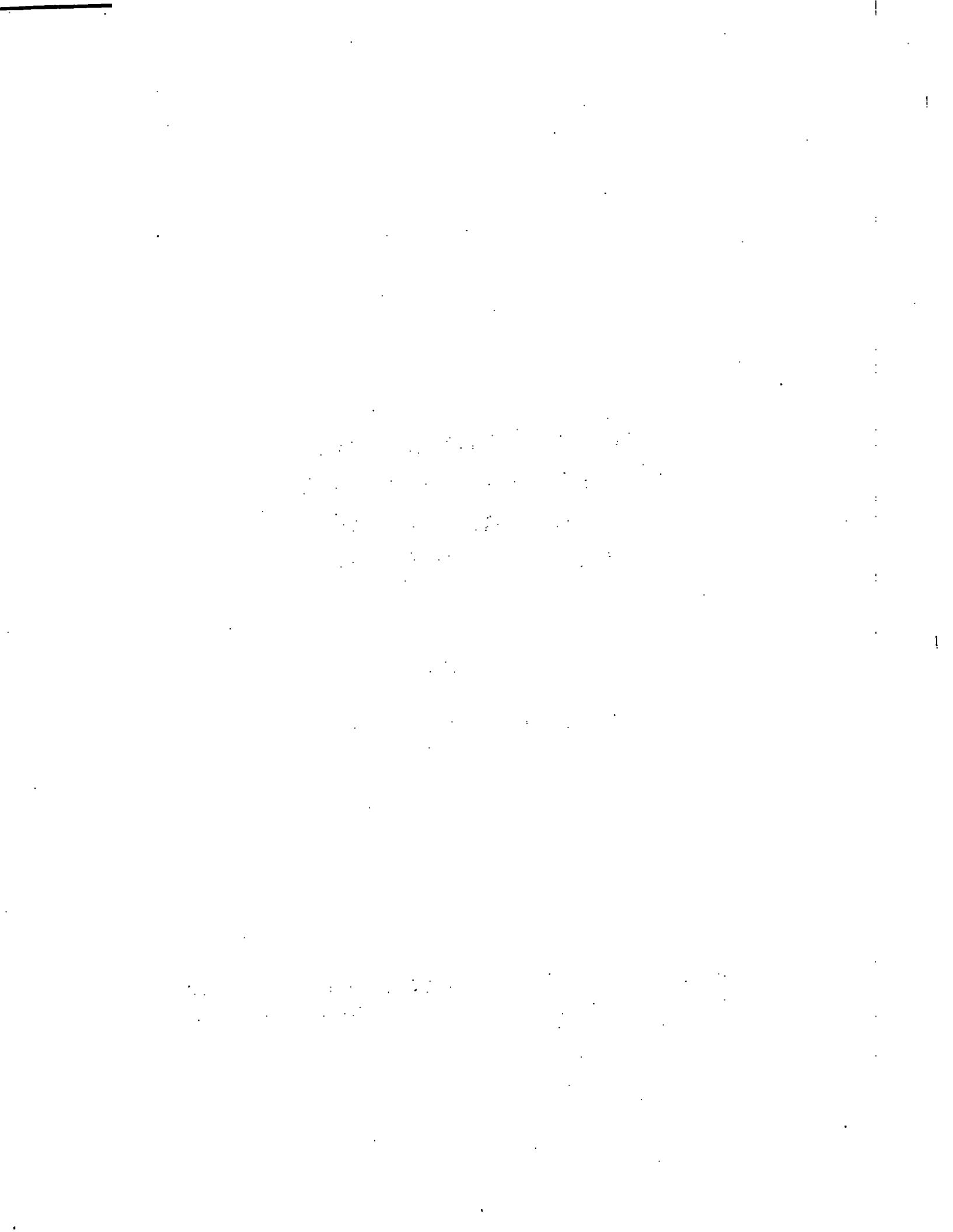
W. C. Dickinson

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LAWRENCE LIVERMORE NATIONAL LABORATORY
University of California • Livermore, California • 94550

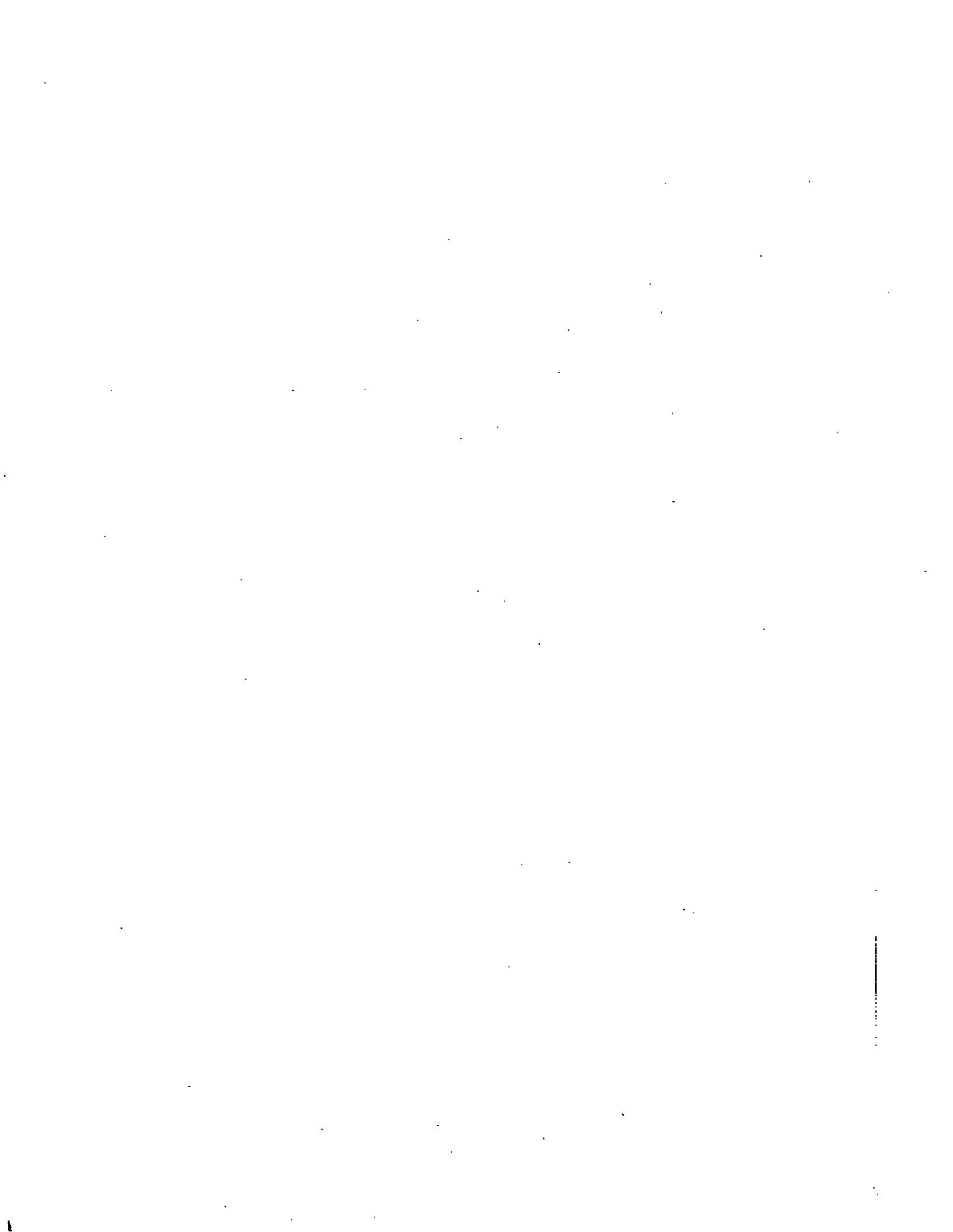


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SPATIAL DISTRIBUTION OF RADIATION FROM THE
BEAM LINE VIII-W 15-PERIOD WIGGLER

ABSTRACT

We have written a computer program to calculate the spatial distribution of the radiation from insertion devices operating in nominal wiggler mode ($K = 15.6$), for which the incoherent emission dominates, and our assumption of negligible coherent emission is valid. This program has been applied to the 15-period wiggler now being designed by the Lawrence Berkeley Laboratory for Beam Line VIII-W on the Stanford Positron-Electron Accumulation Ring (SPEAR). An approximate spreading function has been applied at each photon energy to account for the intrinsic photon divergence. The effects of the finite wiggler length and the spatial and angular spread of the electron beam have been included.

Graphical plots are provided for three different electron energies, 1.8 GeV, 3.0 GeV, and 3.4 GeV, and for a range of photon energies. Separate plots are provided for total radiation, parallel polarization component, and perpendicular polarization component.

INTRODUCTION

The University of California/National Laboratory Team plans to install a 15-period wiggler as part of the Stanford Positron-Electron Accumulation Ring (SPEAR) when SPEAR shuts down for the summer of 1986. The wiggler, which is being designed and built by the Lawrence Berkeley Laboratory, has spatially periodic, high magnetic fields that confine the electron beam to a horizontal, sinusoidal path, thus producing copious amounts of radiation with no net horizontal displacement or deflection of the electron beam. To properly design experimental equipment for the wiggler beam line (Beam Line VIII-W), it is desirable to accurately characterize the spatial distribution of the wiggler's radiation as a function of photon energy.

DISCUSSION

Schwingen[1] presents an expression for the instantaneous power radiated in a narrow energy band by a monoenergetic electron in circular orbit. This expression can be used in the following convenient form:

$$N(\epsilon, \psi, \theta) = 3461(\epsilon/\epsilon_c)^2 \frac{\gamma^2 A}{s^2 m_e^2 k_B^2 \psi^2 \theta} \text{ photons in } 0.1\% \text{ bandwidth}, \quad (1)$$

where ψ is the angle between the direction of emission and the instantaneous orbital plane, and θ is the angle, projected on the orbital plane, between the direction of emission and direction of motion. The beam is characterized by a vertical angular spread $\psi \approx 1/\gamma$ and a horizontal angular spread $\theta \approx K/\gamma$, where

$$\gamma = E/m_0 c^2, \quad (2)$$

$$K = 0.0934 B \lambda, \quad (3)$$

E is the electron energy in GeV, B is the magnetic field strength in kG, and λ is the wiggler wavelength in cm. The factor A is given by

$$A = (1+x^2)^2 [K_{2/3}^2(\xi) + \frac{x^2}{1+x^2} K_{1/3}^2(\xi)], \quad (4)$$

where

$$x = \gamma \psi, \quad (5)$$

and

$$\xi = \frac{\epsilon}{2\epsilon_c} (1+x^2)^{3/2}. \quad (6)$$

The critical energy ϵ_c is given by

$$\epsilon_c (\text{keV}) = 2.218 E^3 / \rho = 0.06651 B E^2, \quad (7)$$

where ρ is radius of curvature in m. The factors $K_{1/3}$ and $K_{2/3}$ are modified Bessel functions of the second kind, for which a tabular listing of values is given in Chapter 2 of [2]. The $K_{2/3}$ term in the expression for A represents radiation polarized with the electric vector parallel to the orbital plane, whereas the $K_{1/3}$ term represents radiation polarized with the electric vector perpendicular to the orbital plane. Note that in the orbital plane ($\psi = 0$), the radiation is 100% horizontally polarized.

Eq. (1) is to be applied over the sinusoidal path of the electron as it traverses the wiggler. For a given photon energy, this is done by dividing a single quadrant of a wiggler wavelength λ into a number of intervals of equal length. Each interval is characterized by average values of ρ , ϵ_c , and θ . The total radiation at angle θ is then obtained by multiplying by twice the number of wiggler periods.*

It is convenient to express Eq. (1) in terms of a spatial distribution of radiation in the x-y plane at a distance R from the wiggler source. Hence,

$$N(\epsilon, x, y, R) = 3461 (\epsilon/\epsilon_c)^2 \frac{\gamma^2 A}{R^2} \frac{\text{photons in } 0.1\% \text{ bandwidth}}{\text{s} \cdot \text{mA} \cdot \text{mm}_x \cdot \text{mm}_y}, \quad (8)$$

where R is in m. If the total length of the wiggler is much less than R , all radiation can be assumed (to good approximation) to originate from the center point of the wiggler length. However, our wiggler will be 2 m long, and the x-y plane of interest is 8.5 m from the wiggler center (the position of the first reflecting mirror). Therefore, we must take into account the finite photon source length by applying Eq. (8) to several points along the wiggler length and appropriately summing the results.

Eq. (1) applies only to electrons traveling in circular orbit. For the sinusoidal path of an electron in our wiggler, a horizontal spreading function must be applied to Eq. (1). This is approximated by a Gaussian distribution with standard deviation at low photon energy [3] ($\epsilon \ll \epsilon_c$)

$$\sigma = \frac{1}{\gamma} (\epsilon_c/\epsilon)^{1/3}, \quad (9)$$

and for high photon energy ($\epsilon > \epsilon_c$),

*Two quadrants in each wiggler period contribute radiation to one side of the wiggler axis, and the other two quadrants to the other side. For our wiggler, since the horizontal excursion of the electron from the wiggler axis is only about 0.05 mm, this spreading effect can be neglected.

$$\sigma = \frac{1}{\gamma} (\epsilon_c/3\epsilon)^{1/2} . \quad (10)$$

A suitably smooth transition is made between these two functions over our range of photon energies. Although the above widths are valid only for unpolarized radiation, this same spreading was also applied to the horizontal and vertical components. A more exact treatment is beyond the scope of this work.

Also, a "smearing" function must be introduced to take into account the spatial and angular smearing of the electron beam in the storage ring. For the SPEAR, this smearing can be characterized by the following set of vertical and horizontal standard deviations:

$$\sigma_H \approx 2.5 \text{ mm}$$

$$\sigma_V \approx 0.15 \text{ mm}$$

$$\sigma'_H \approx 0.18 \text{ mR}$$

$$\sigma'_V \approx 0.03 \text{ mR}$$

At the distance R from the photon source, these angular and spatial spreads can be combined into a single horizontal and a single vertical standard deviation. Therefore, for $R = 8.5 \text{ m}$, $\sigma_H(\text{TOTAL}) = 2.9 \text{ mm}$ and $\sigma_V(\text{TOTAL}) = 0.3 \text{ mm}$.

This smearing is accomplished by first doing a one-dimensional convolution in the horizontal (x) direction for each vertical (y) displacement and then convolving in the vertical direction for each horizontal displacement. In each case, the Gaussian of appropriate width is used in the convolution.

EXPLANATION OF FIGURES

In Appendix A, we show, as a matter of interest, the individual contributions of each of these smearing effects on the final photon spatial distributions. We conclude that for low photon energies ($\epsilon \ll \epsilon_c$), the final photon spatial distributions are determined almost entirely by the intrinsic spreading of the photon beam, whereas at high photon energies ($\epsilon \geq \epsilon_c$), the effect of the electron beam spatial and angular spread on the final photon distributions, although not terribly important, is still not negligible.

In Appendix B, one set of computer-generated figures is provided for each of the following three electron energies: 1.80 GeV, 3.00 GeV, and 3.40 GeV. It should be noted that all the plots include the three smearing effects described above: 1) the intrinsic horizontal spread of the photon beam, 2) the effect of finite wiggler length, and 3) the effect of the assumed spatial and angular spread of the electron beam in the SPEAR. Each figure is an isometric plot of photon intensity, in a single quadrant, for the listed photon energy at 8.50 m from the center of the wiggler. For each electron energy, plots are provided for the following photon energies: 20 eV, 100 eV, 500 eV, 1 keV, $\epsilon_c/2$, ϵ_c , and $5 \epsilon_c$. The wiggler wavelength (λ_w) is 12.85 cm, and the maximum wiggler magnetic field (B_0) is 13.0 kG. The critical energy, ϵ_c , is given for the point along the electron's sinusoidal path with the smallest radius of curvature.

Plots are provided for total intensity, intensity of the parallel polarization component, and intensity of the perpendicular polarization component. For the total and parallel polarization-intensity plots, the absolute intensity at the center of the photon distribution ($x = 0, y = 0$) is listed in the lower left-hand corner of each plot. For the perpendicular polarization plots, the listed absolute intensity is for the point of maximum intensity along the y axis ($x = 0$). Intensity is given in the following units:

photons in 0.1% bandwidth at energy ϵ
 $s^{-1} mA^{-1} mm_x^{-1} mm_y^{-1}$

Each isointensity curve in a plot represents a fraction (listed in the table in the upper right-hand corner) of the listed absolute intensity. Two sets of intensity curves are shown in each plot. For the total and parallel polarization-intensity plots, these curves represent photon intensity along the x axis at $y = 0$ and along the y axis at $x = 0$. For the perpendicular polarization intensity plots, these curves represent photon intensity along the y axis at $x = 0$ and along the x axis at the value of y for which the absolute intensity is given. In Appendix C, we provide, for each of the above plots, a table listing the integrated absolute number of photons (per second, per mA in 0.1% bandwidth) in bins that are 2 mm high by 5 or 10 mm wide.

REFERENCES

1. J. Schwinger, "On the Classical Radiation of Accelerated Electrons," Phys. Rev. 75, 1912 (1949).
2. H. Winick and S. Doniach (Eds.), Synchrotron Radiation Research, Plenum Press, New York, (1980).
3. J.D. Jackson, Classical Electrodynamics, Wiley & Sons, New York, (1962).

APPENDIX A

ILLUSTRATION OF CONTRIBUTIONS OF SMEARING FUNCTIONS ON PHOTON SPATIAL DISTRIBUTIONS

It is interesting to plot the photon spatial distributions as given by the Schwinger formula, Eq. (1), and then add the requisite smearing contributions, one at a time, to observe the effect of each in determining the final spatial distributions. The following figures show the results at one electron energy, $E = 3 \text{ GeV}$, and two photon energies, $\epsilon = 20 \text{ eV}$ and $\epsilon = \epsilon_c = 7.78 \text{ keV}$.

The first set of four figures is for $\epsilon = 20 \text{ eV}$. Figure A1 is just a plot of Eq. (1). Note the very sharp cutoff at the outer edge of the distribution. In Fig. A2 is the distribution when the intrinsic horizontal spread of the photon beam is convoluted with Eq. (1). Although there is no effect on the intensity at the center ($x = 0, y = 0$), there is a strong smearing out of the distribution at the outer edge. To this smeared distribution, Fig. A3 adds the finite wiggler length, which has almost no effect on the spatial distribution. Finally, Fig. A4 adds the convolution of the assumed spatial and angular spread of the electron beam in the storage ring. Again, there is almost no effect on the spatial distribution. Therefore, we conclude that at very low photon energies, the final spatial distribution is almost completely governed by the intrinsic vertical and horizontal spreading of the photon beam.

The second set of four figures is for $\epsilon = \epsilon_c = 7.78 \text{ keV}$. Figure A5 is again a plot of Eq. (1). Figure A6 convolutes the intrinsic horizontal spread of the photon beam. The effect is seen to be negligible. Figure A7 adds the finite wiggler length. The result is a small additional increase in the horizontal beam spread. Figure A8 adds the effect of convoluting the assumed spatial and angular spread of the electron beam in the storage ring. This results in an additional small spreading of the photon distribution, both vertically and horizontally. We conclude that at higher energies, the only noticeable effect of the smearing functions on the final photon spatial distribution is that due to the spatial and angular spread of the electron beam, and even this is not very important.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $2.00e-02$ keV

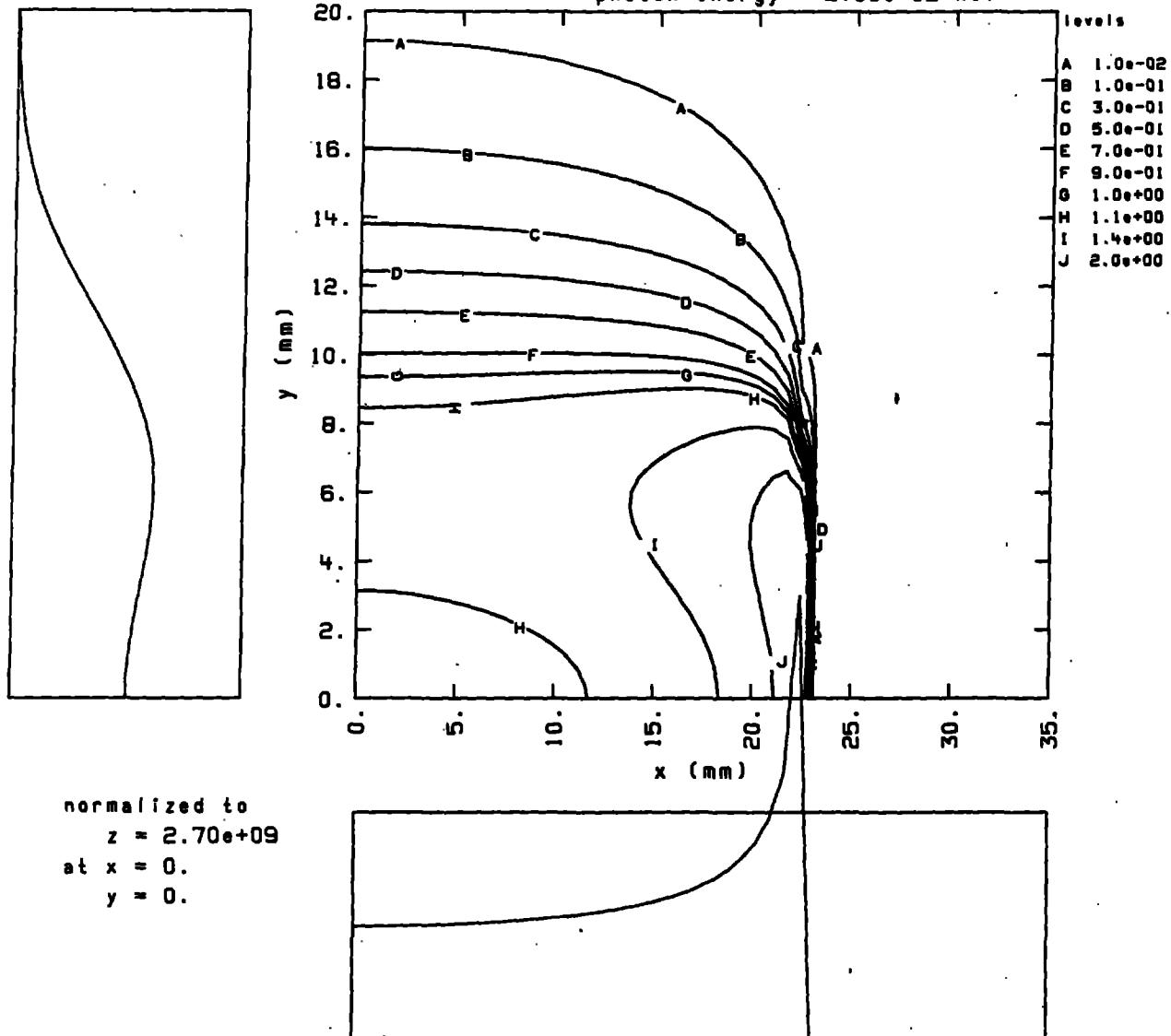
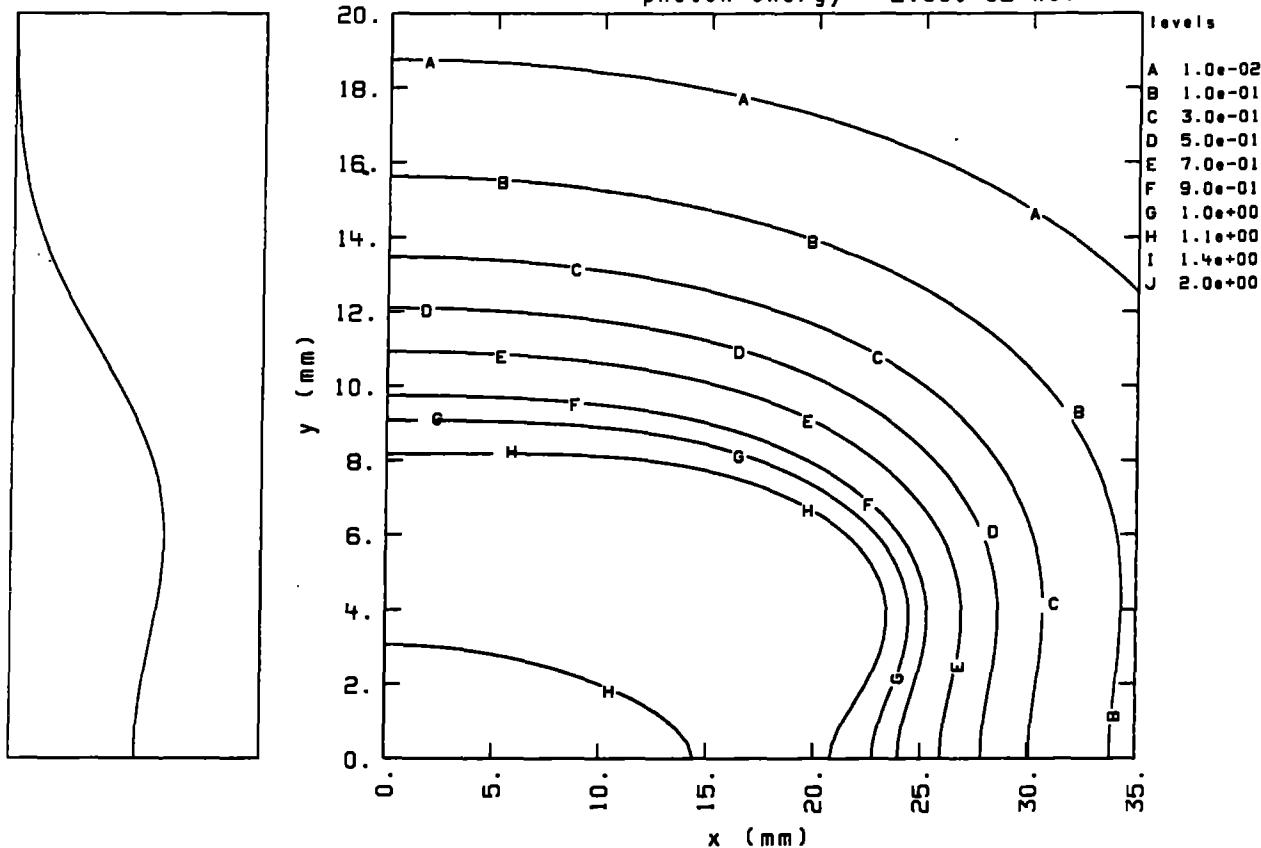


Fig. A1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $2.00e-02$ keV

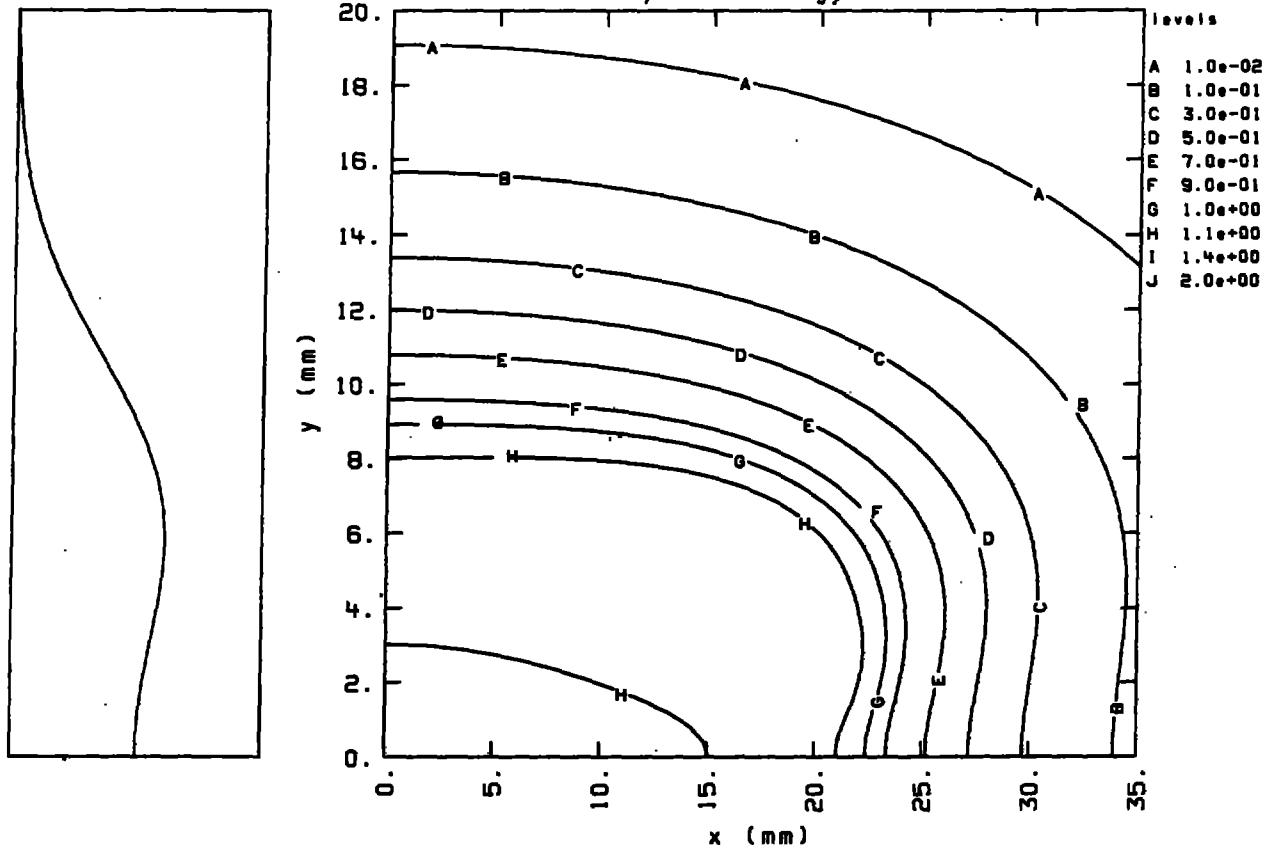


normalized to
 $z = 2.68e+09$
 at $x = 0.$
 $y = 0.$



Fig. A2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $2.00e-02$ keV



normalized to
 $z = 2.71e+09$
 at $x = 0.$
 $y = 0.$

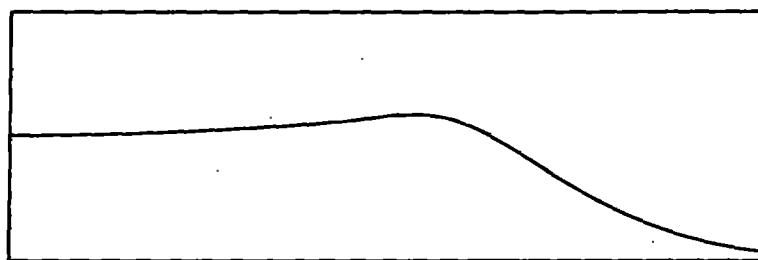
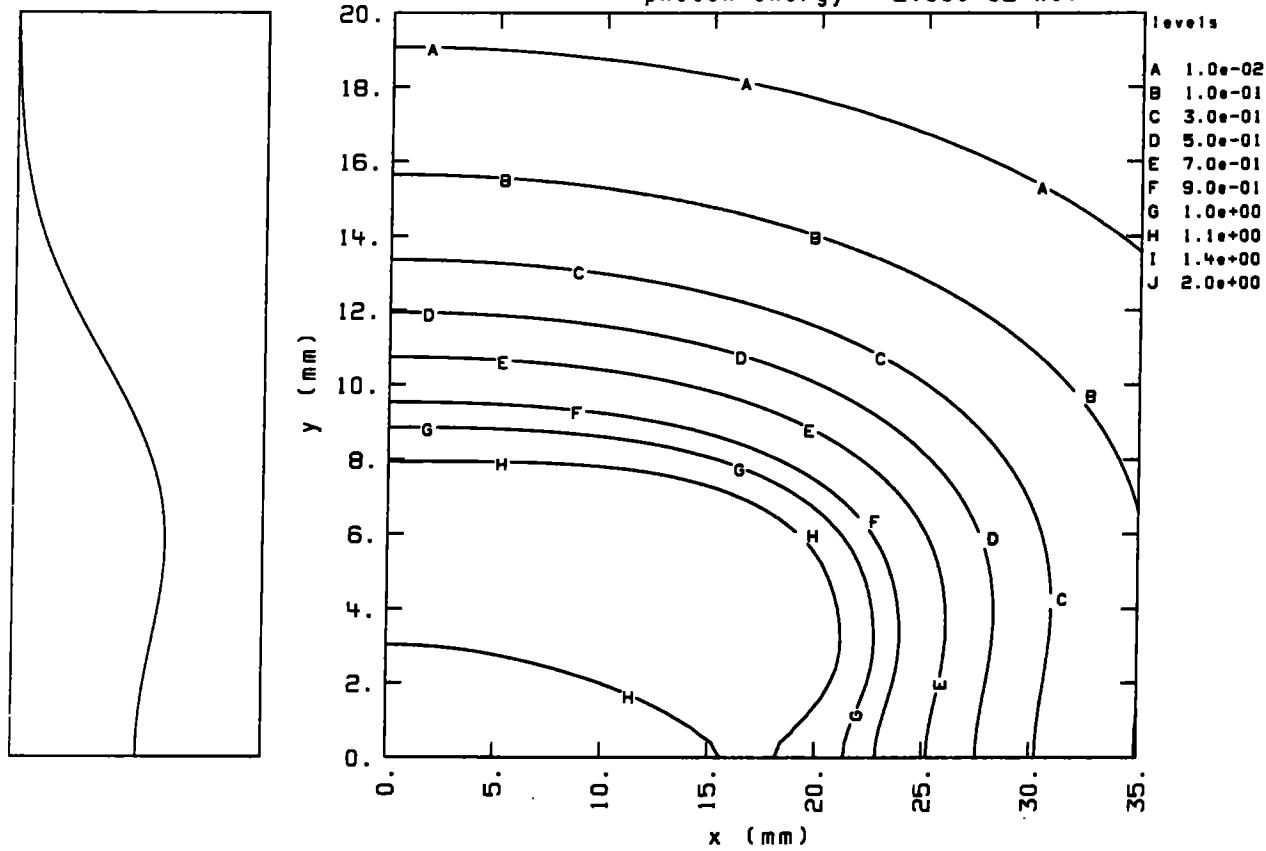


Fig. A3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $2.00e-02$ keV



normalized to
 $z = 2.73e+09$
 at $x = 0.$
 $y = 0.$

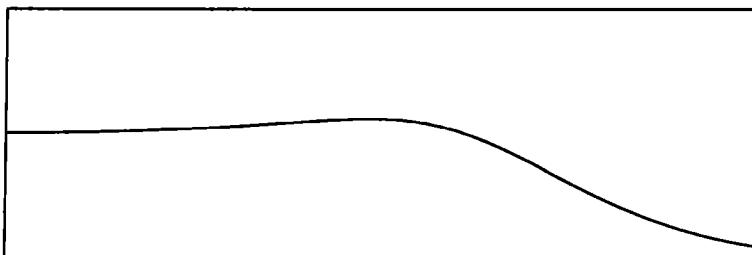
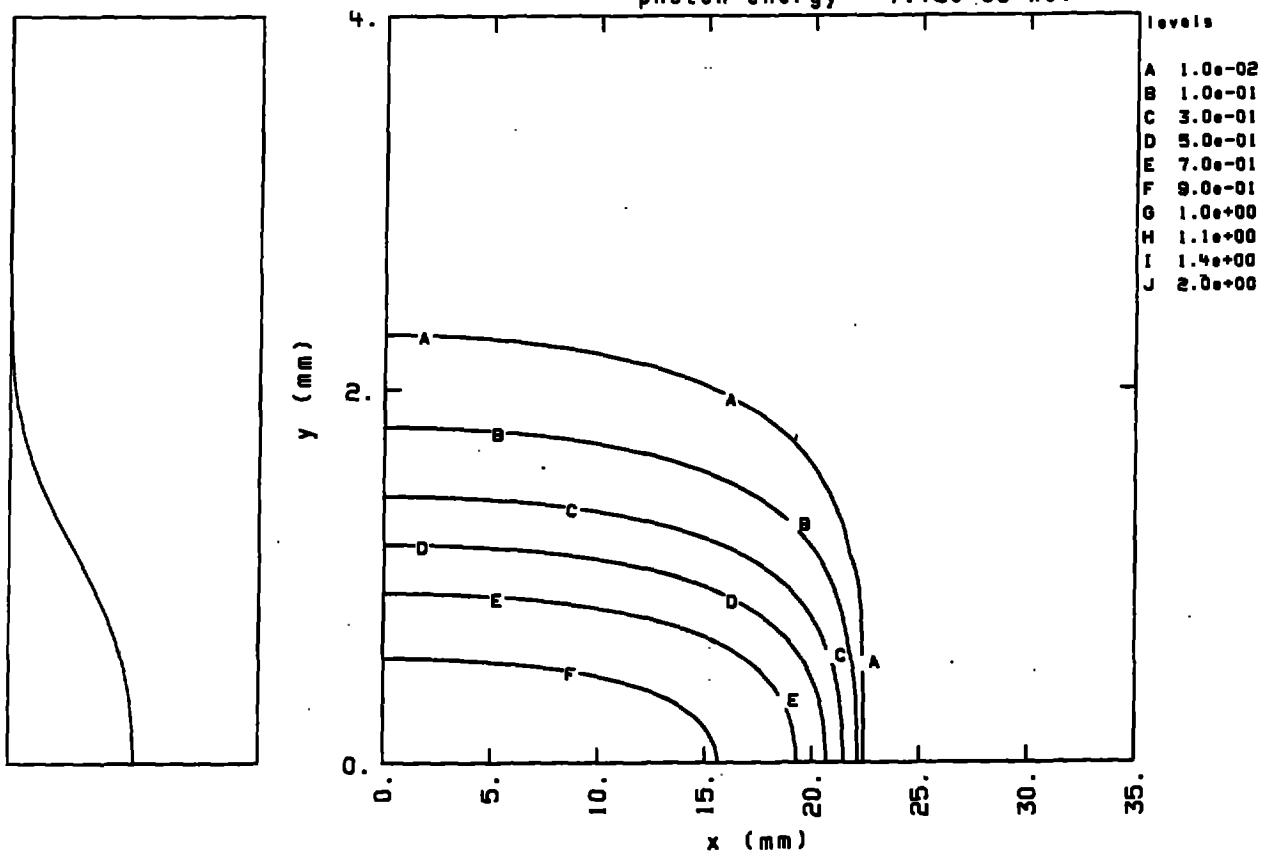


Fig. A4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $7.78e+00$ keV



normalized to
 $z = 7.20e+10$
 at $x = 0.$
 $y = 0.$

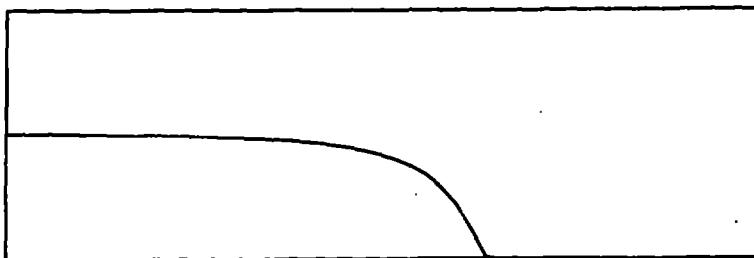


Fig. A5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $7.78e+00$ keV

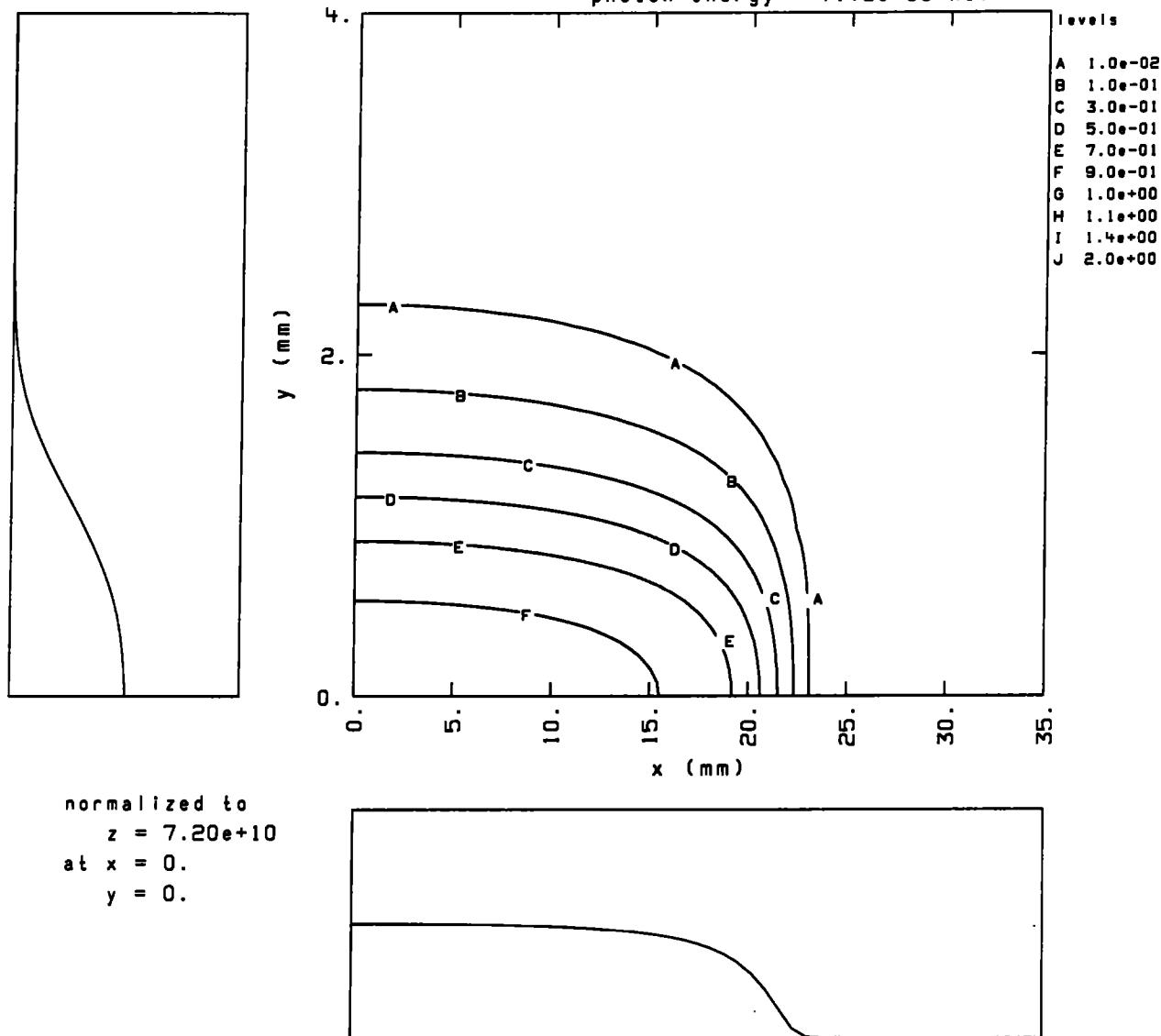
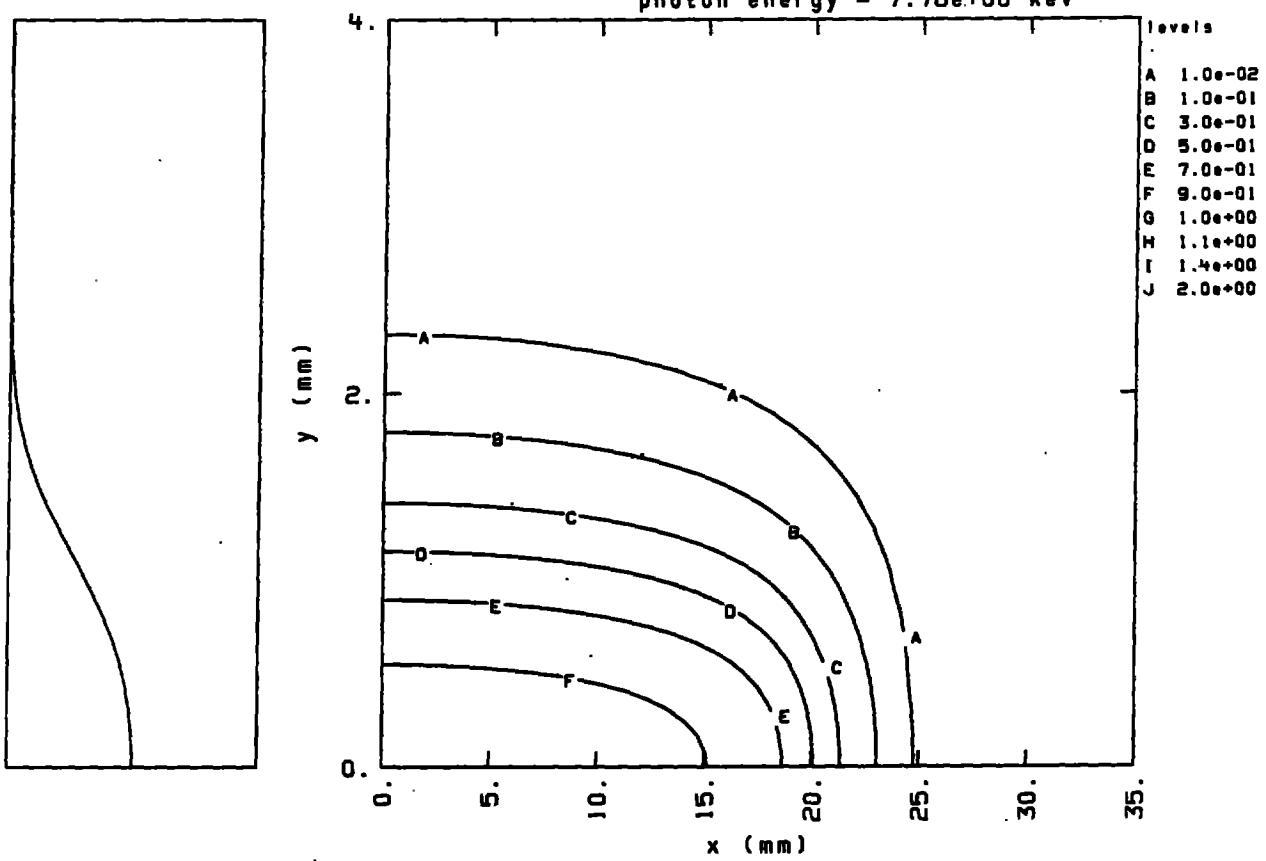


Fig. A6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $7.78e+00$ keV



normalized to
 $z = 7.29e+10$
 at $x = 0.$
 $y = 0.$

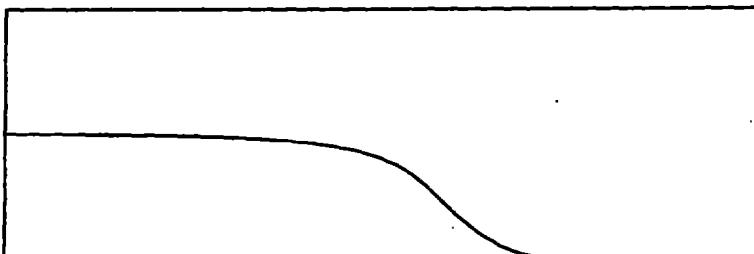
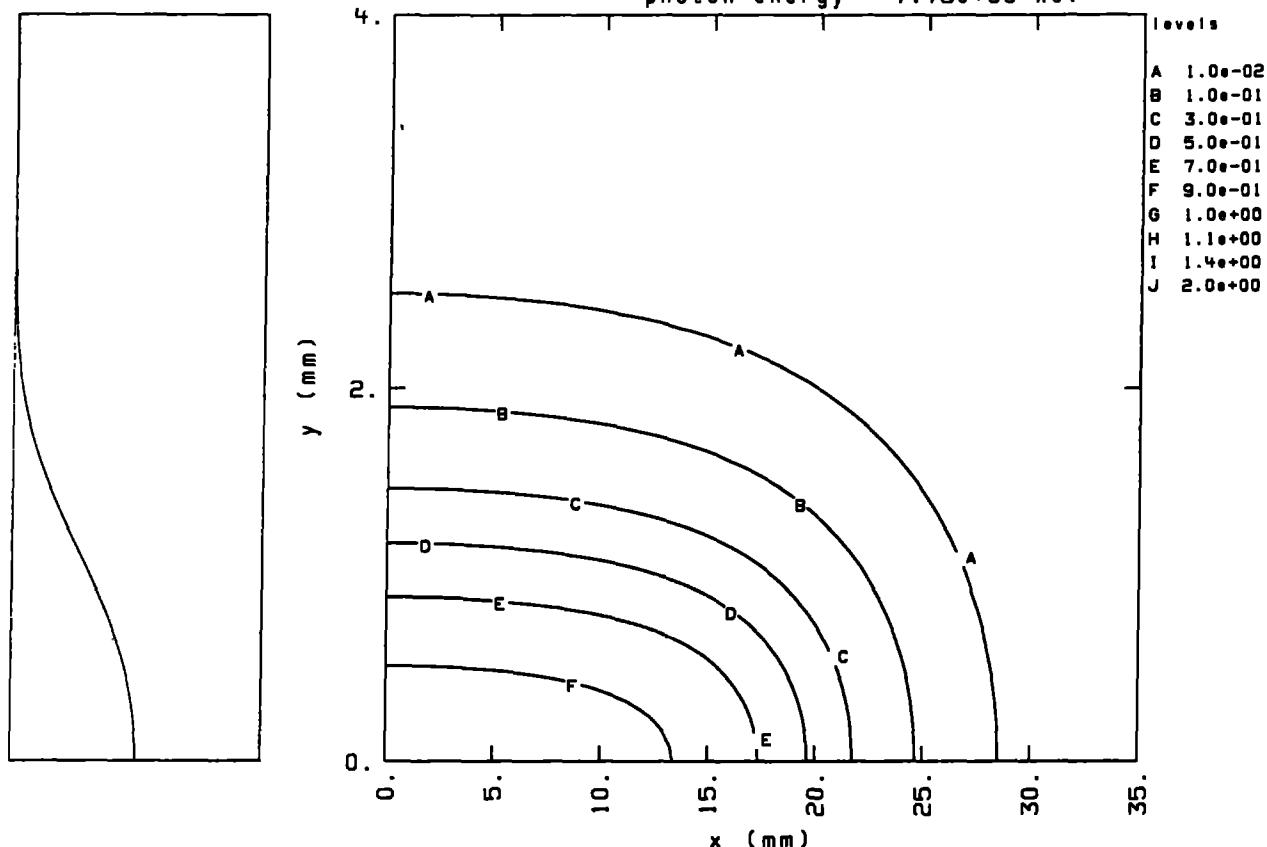


Fig. A7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $7.78e+00$ keV



normalized to
 $z = 7.08e+10$
 at $x = 0.$
 $y = 0.$

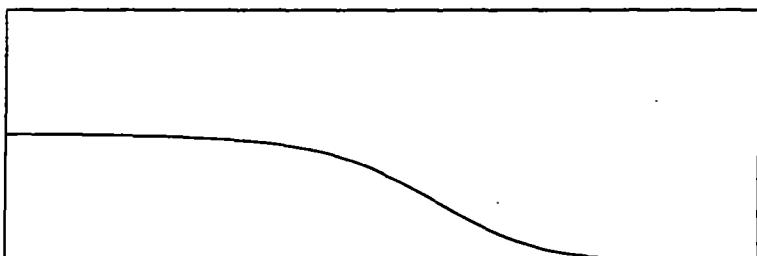


Fig. A8.

APPENDIX B
COMPUTER-GENERATED FIGURES

List of figures:

Total intensity for $E = 1.8 \text{ GeV}$ ($\epsilon_c = 2.80 \text{ keV}$)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B1.1	20 eV	18
B1.2	100 eV	19
B1.3	500 eV	20
B1.4	1 keV	21
B1.5	$\epsilon_c/2$	22
B1.6	ϵ_c	23
B1.7	$5\epsilon_c$	24

Parallel polarization intensity for $E = 1.8 \text{ GeV}$ ($\epsilon_c = 2.80 \text{ keV}$)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B2.1	20 eV	25
B2.2	100 eV	26
B2.3	500 eV	27
B2.4	1 keV	28
B2.5	$\epsilon_c/2$	29
B2.6	ϵ_c	30
B2.7	$5\epsilon_c$	31

Perpendicular polarization intensity for $E = 1.8 \text{ GeV}$ ($\epsilon_c = 2.80 \text{ keV}$)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B3.1	20 eV	32
B3.2	100 eV	33
B3.3	500 eV	34
B3.4	1 keV	35
B3.5	$\epsilon_c/2$	36
B3.6	ϵ_c	37
B3.7	$5\epsilon_c$	38

Total intensity for $E = 3.0 \text{ GeV}$ ($\epsilon_c = 7.78 \text{ keV}$)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B4.1	20 eV	39
B4.2	100 eV	40
B4.3	500 eV	41
B4.4	1 keV	42
B4.5	$\epsilon_c/2$	43
B4.6	ϵ_c	44
B4.7	$5\epsilon_c$	45

Parallel polarization intensity for E = 3.0 GeV (ϵ_c = 7.78 keV)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B5.1	20 eV	46
B5.2	100 eV	47
B5.3	500 eV	48
B5.4	1 keV	49
B5.5	$\epsilon_c/2$	50
B5.6	ϵ_c	51
B5.7	$5\epsilon_c$	52

Perpendicular polarization intensity for E = 3.0 GeV (ϵ_c = 7.78 keV)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B6.1	20 eV	53
B6.2	100 eV	54
B6.3	500 eV	55
B6.4	1 keV	56
B6.5	$\epsilon_c/2$	57
B6.6	ϵ_c	58
B6.7	$5\epsilon_c$	59

Total intensity for E = 3.4 GeV (ϵ_c = 10.00 keV)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B7.1	20 eV	60
B7.2	100 eV	61
B7.3	500 eV	62
B7.4	1 keV	63
B7.5	$\epsilon_c/2$	64
B7.6	ϵ_c	65
B7.7	$5\epsilon_c$	66

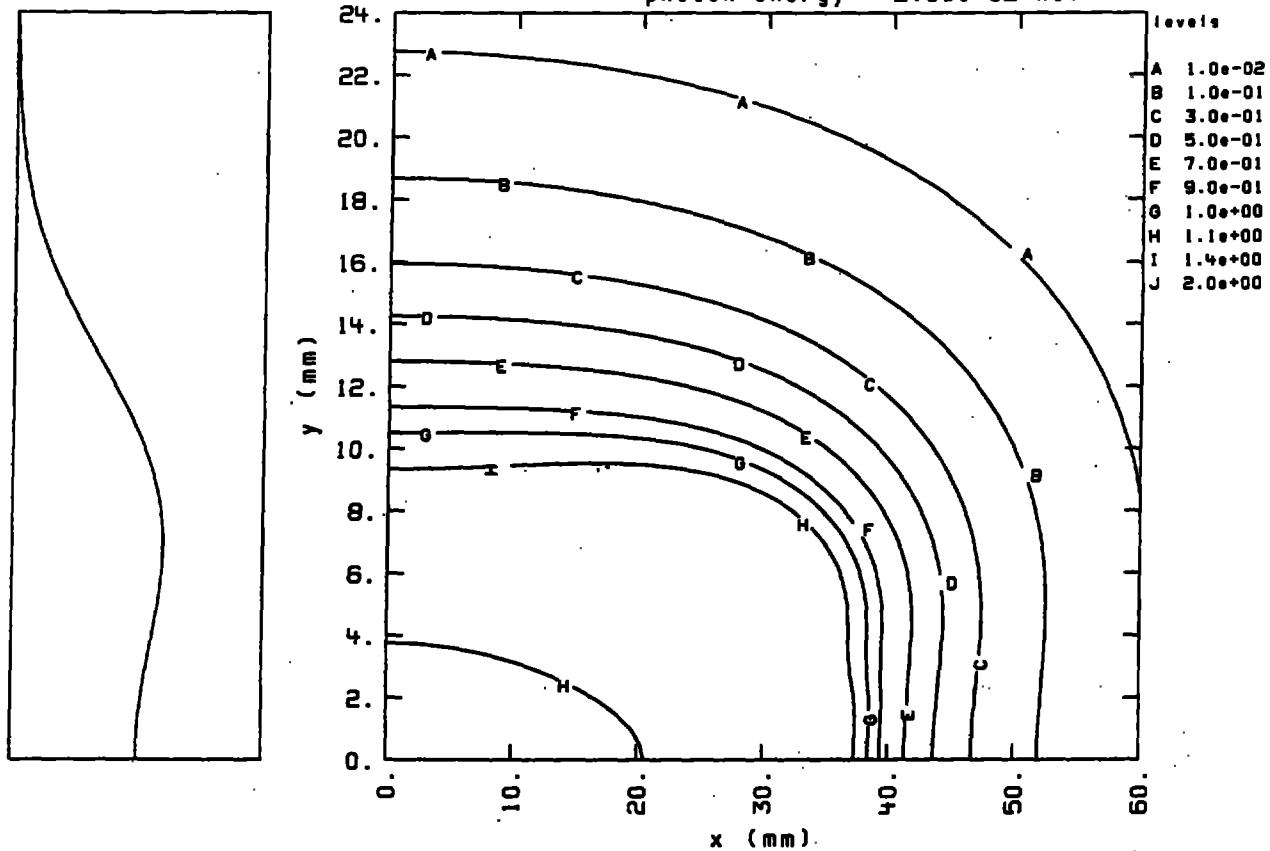
Parallel polarization intensity for E = 3.4 GeV (ϵ_c = 10.00 keV)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B8.1	20 eV	67
B8.2	100 eV	68
B8.3	500 eV	69
B8.4	1 keV	70
B8.5	$\epsilon_c/2$	71
B8.6	ϵ_c	72
B8.7	$5\epsilon_c$	73

Perpendicular polarization intensity for E = 3.4 GeV (ϵ_c = 10.00 keV)

<u>Figure</u>	<u>Photon Energy</u>	<u>Page</u>
B9.1	20 eV	74
B9.2	100 eV	75
B9.3	500 eV	76
B9.4	1 keV	77
B9.5	$\epsilon_c/2$	78
B9.6	ϵ_c	79
B9.7	$5\epsilon_c$	80

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $2.00e-02$ keV



normalized to
 $z = 1.95e+09$
 at $x = 0.$
 $y = 0.$

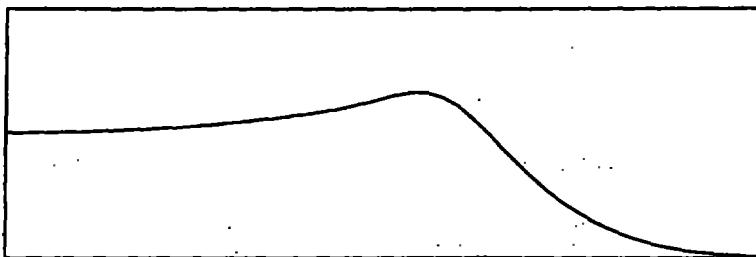
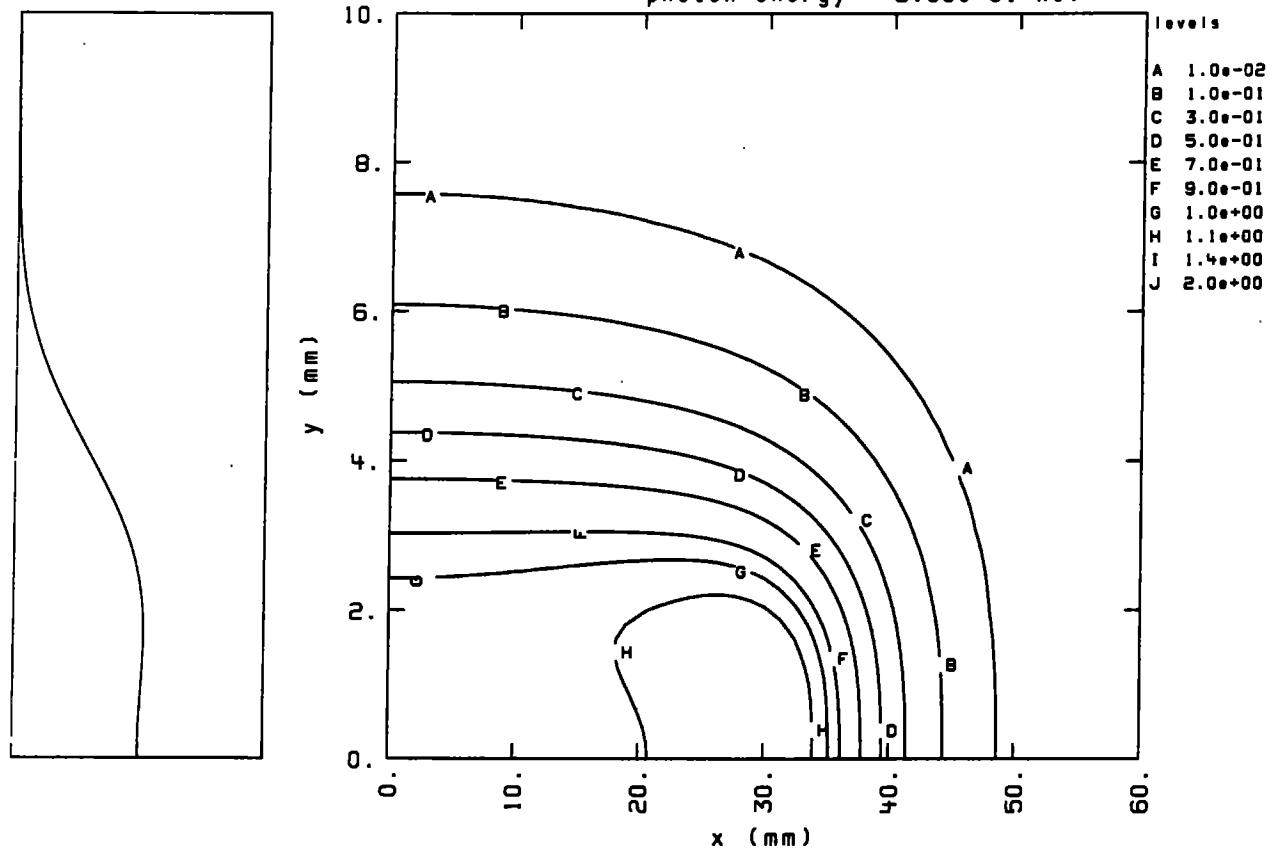


Fig. B1.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $5.00e-01$ keV



normalized to
 $z = 1.54e+10$
 at $x = 0.$
 $y = 0.$

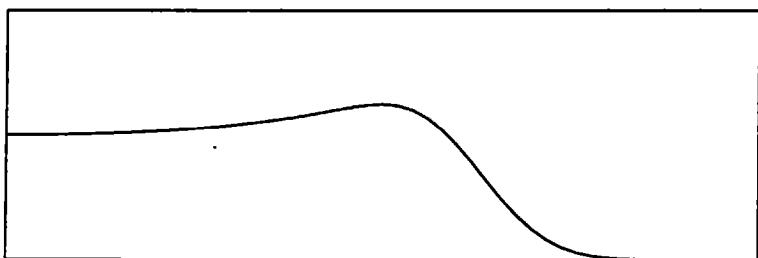
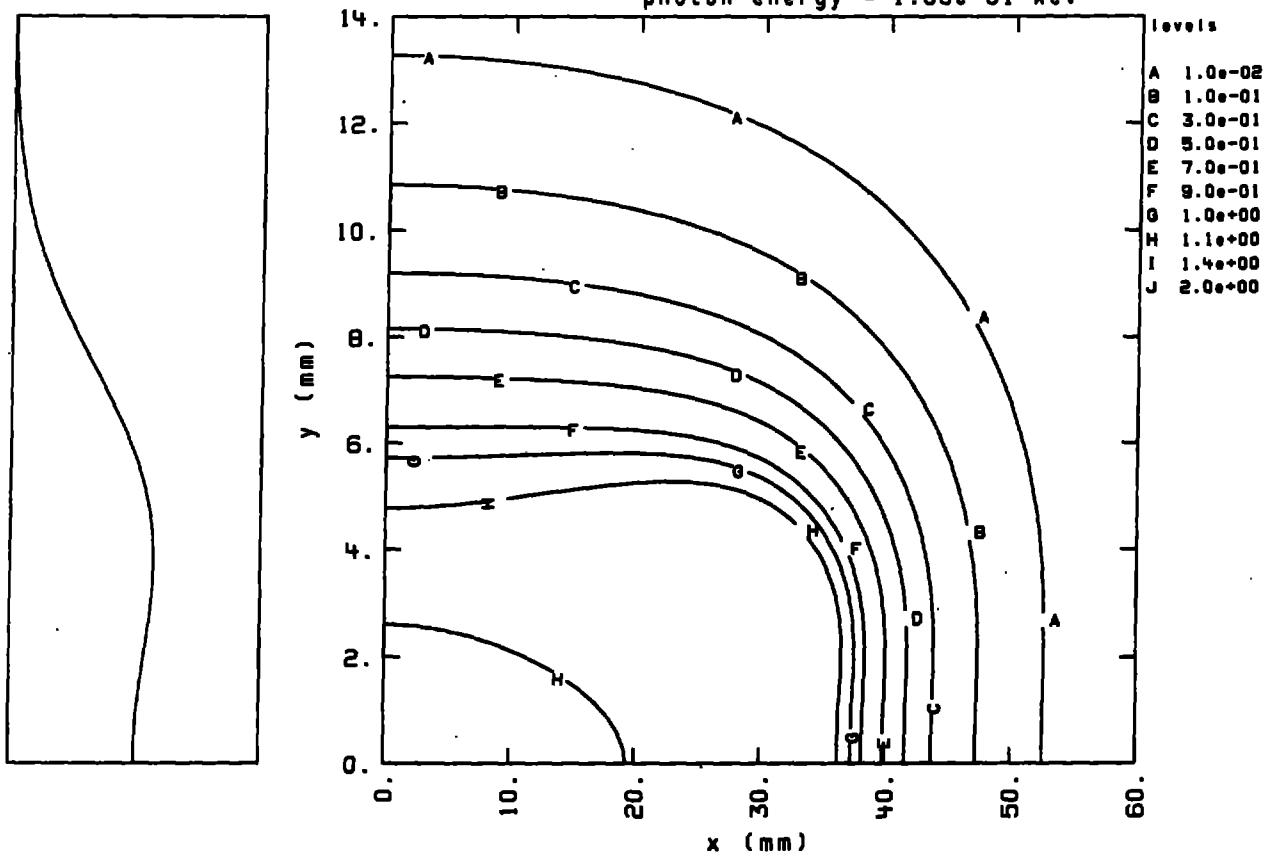


Fig. B1.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e-01$ keV



normalized to
 $z = 5.66e+09$
 at $x = 0.$
 $y = 0.$

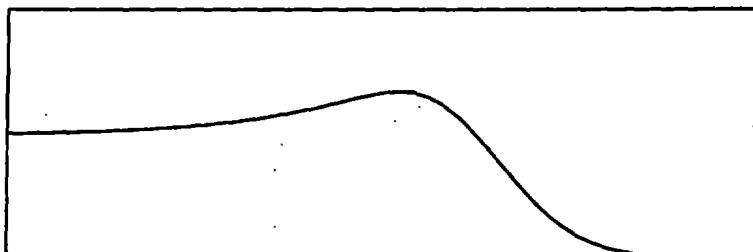
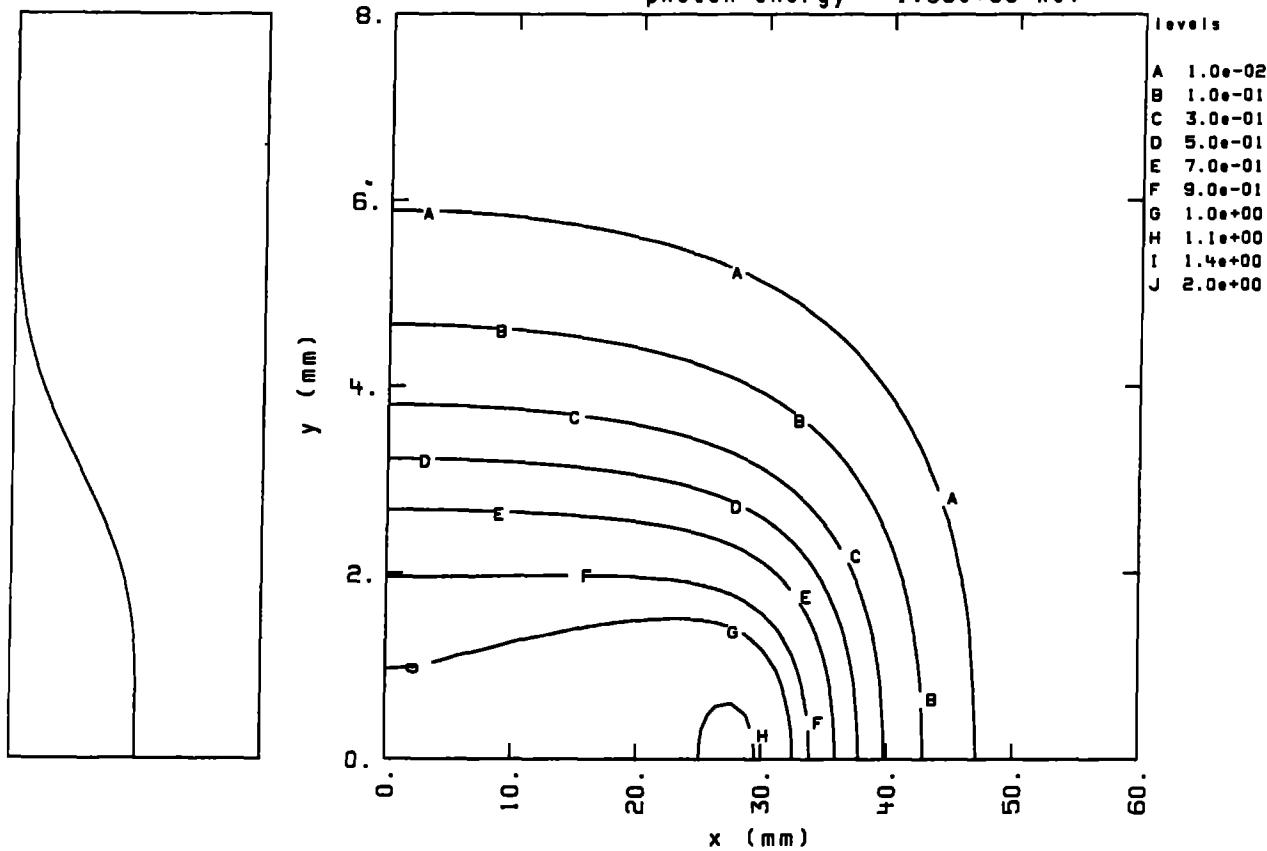


Fig. B1.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e+00$ keV



normalized to
 $z = 2.17e+10$
 at $x = 0.$
 $y = 0.$

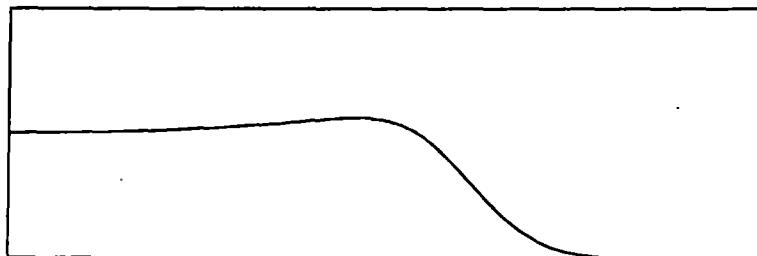
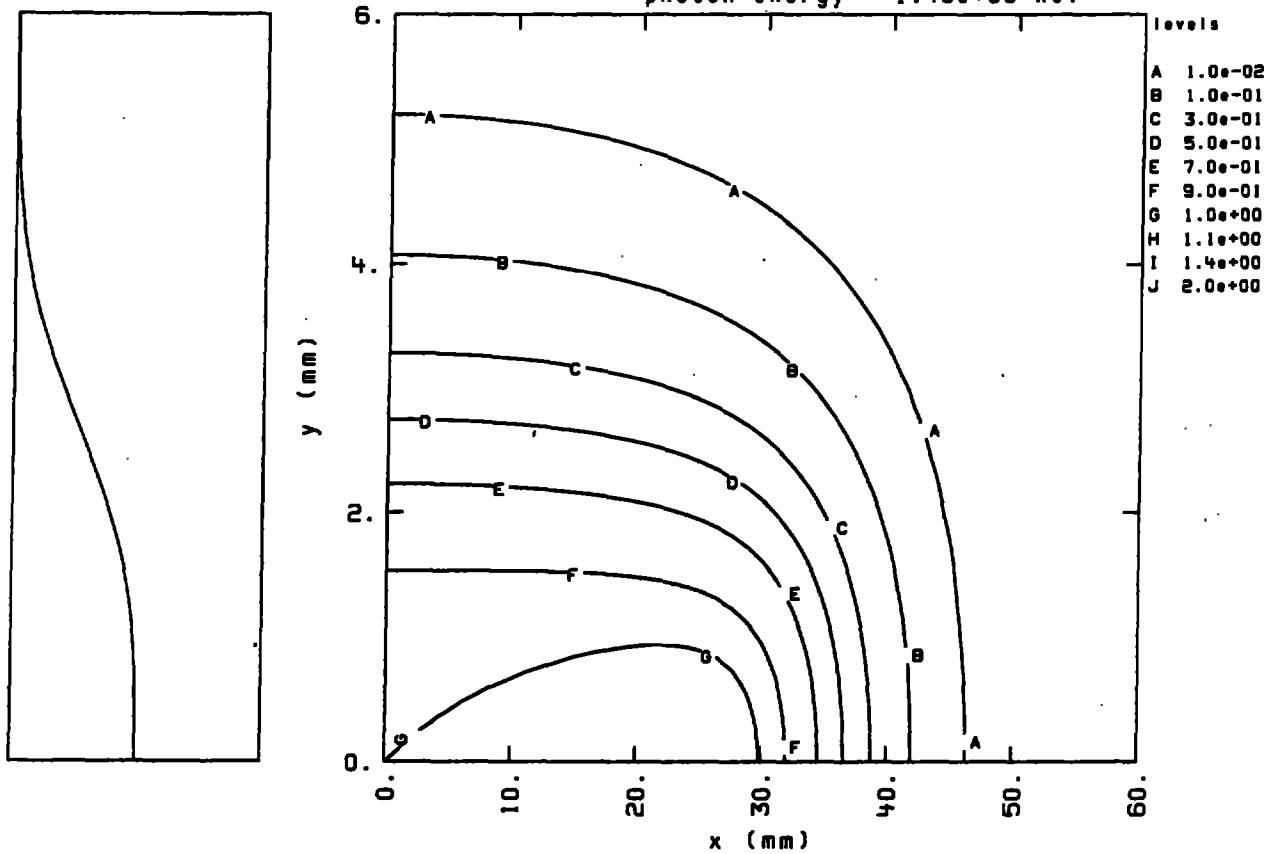


Fig. B1.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.40e+00$ keV



normalized to
 $z = 2.45e+10$
 at $x = 0.$
 $y = 0.$

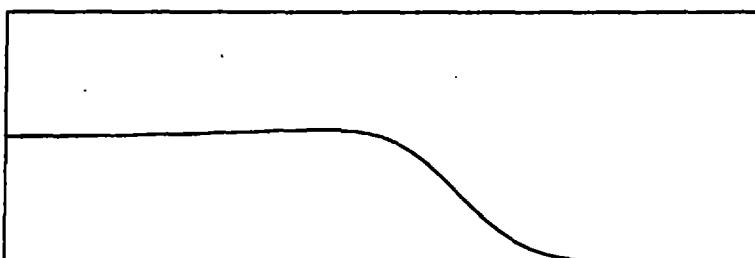


Fig. B1.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $2.80e+00$ keV

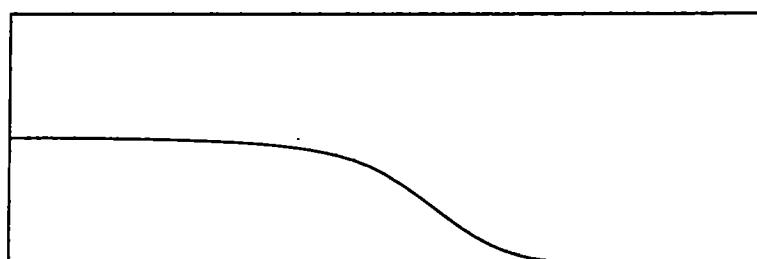
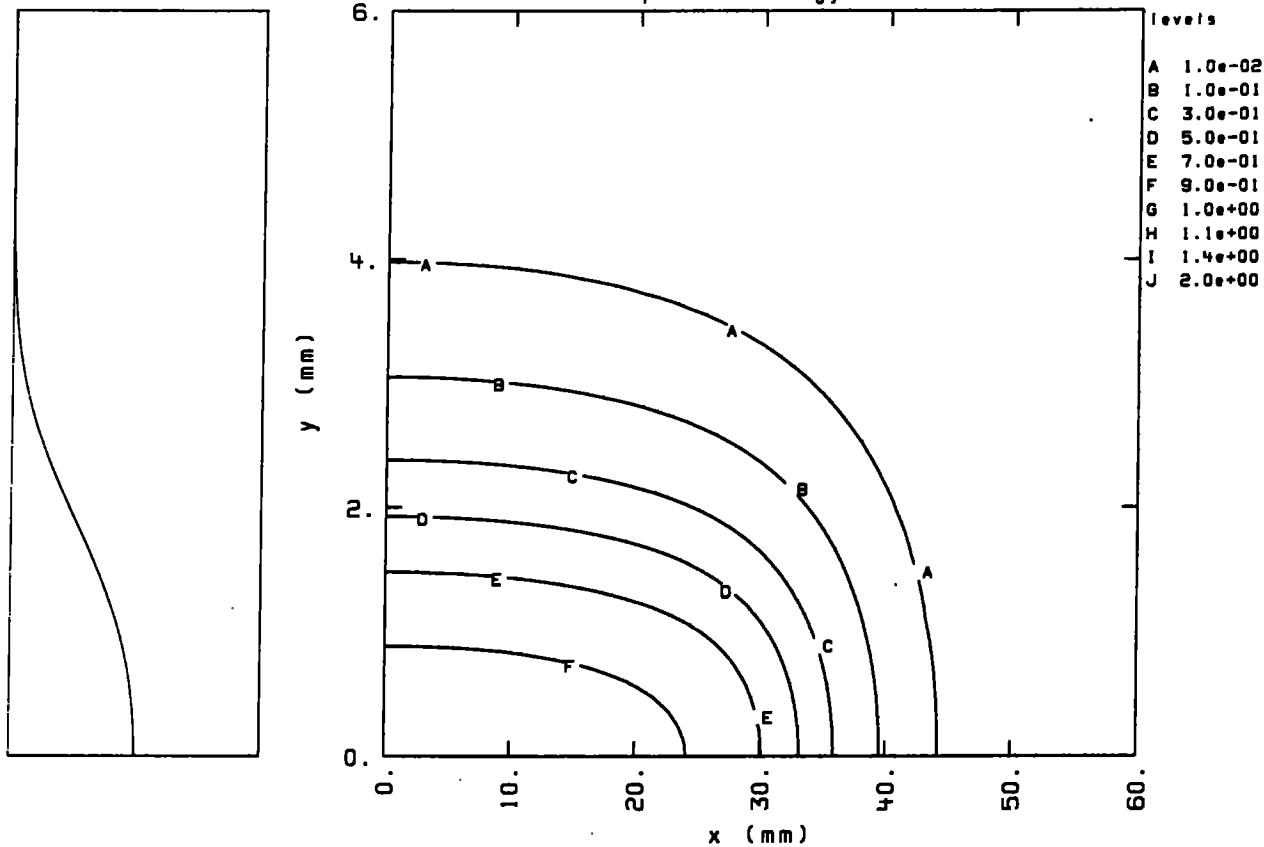
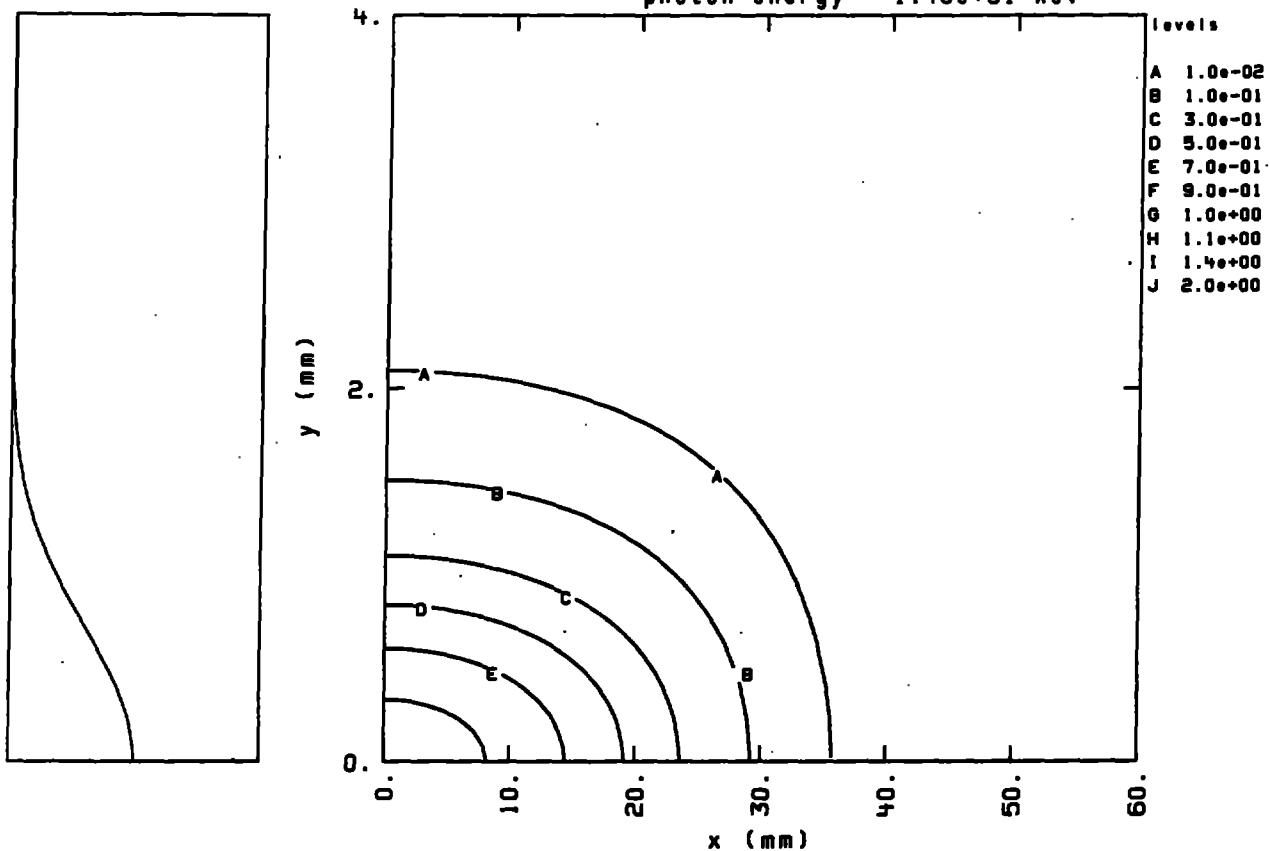


Fig. B1.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 1.80×10^0 GeV critical energy = 2.80×10^0 keV
 photon energy = 1.40×10^1 keV



normalized to
 $z = 1.85 \times 10^9$
 at $x = 0.$
 $y = 0.$

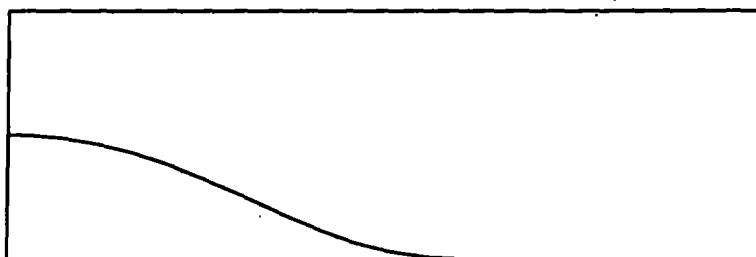
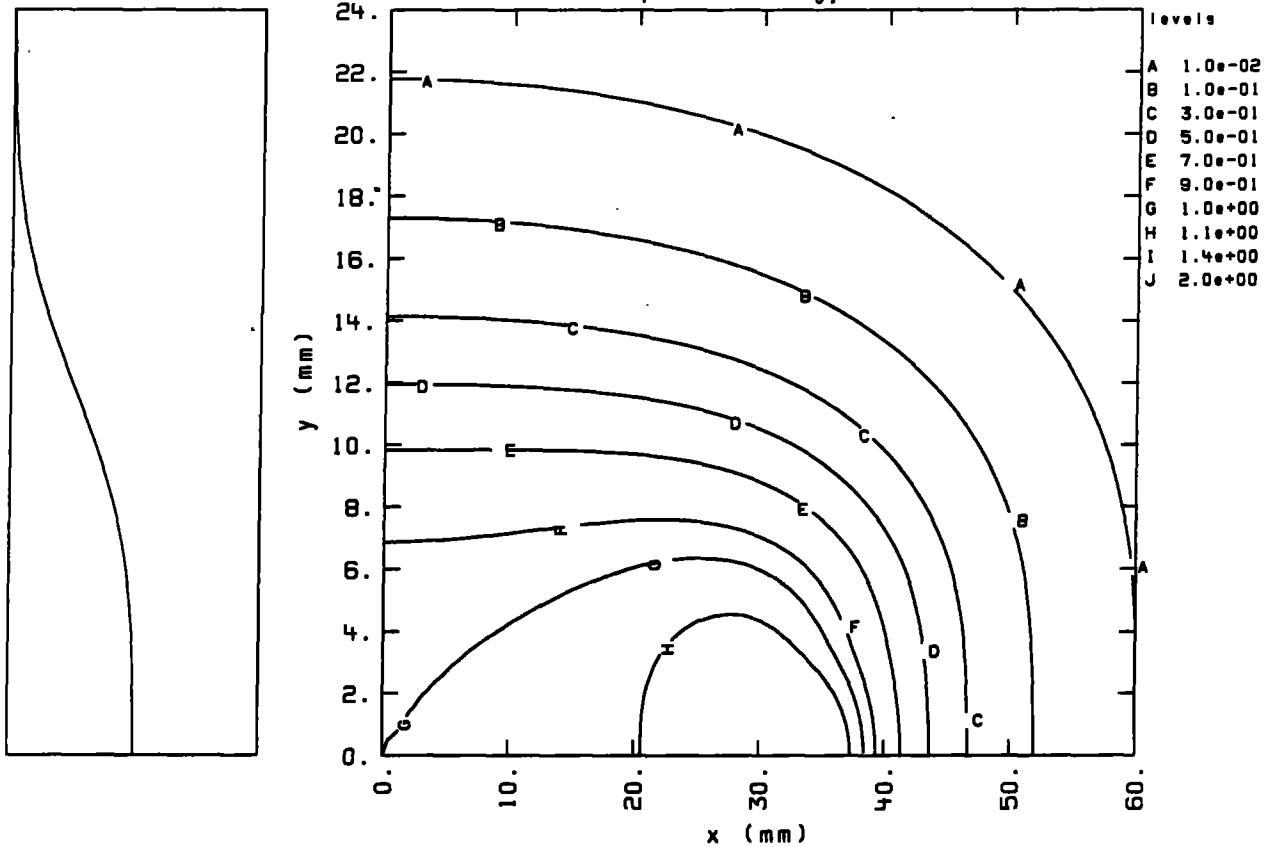


Fig. B1.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 1.80×10^0 GeV critical energy = 2.80×10^0 keV
 photon energy = 2.00×10^{-2} keV



parallel
polarization

normalized to
 $z = 1.95 \times 10^9$
 at $x = 0$.
 $y = 0$.

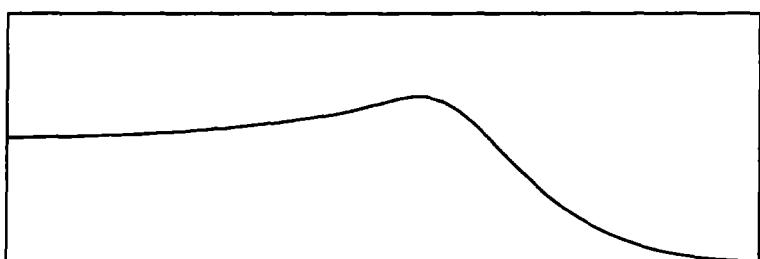
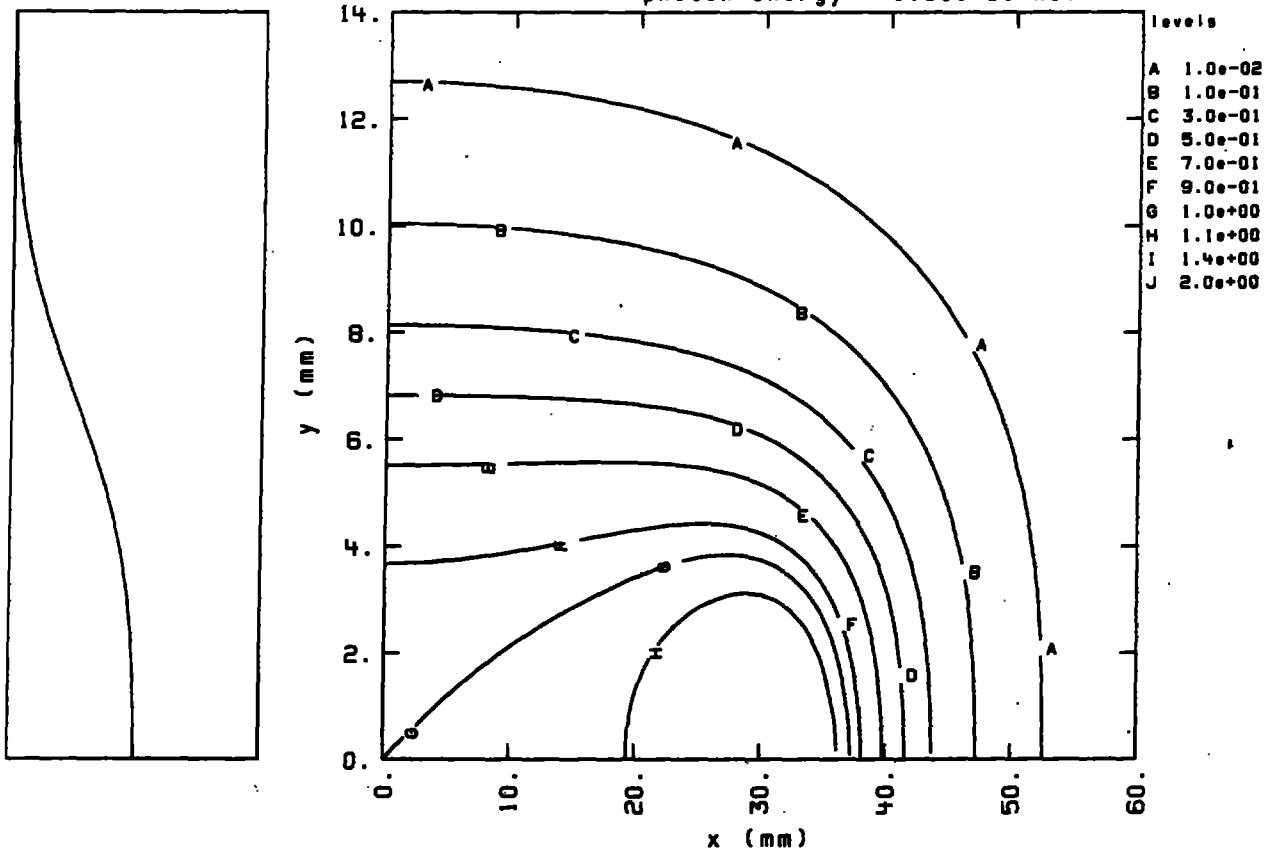


Fig. B2.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e-01$ keV



parallel
polarization

 normalized to
 $z = 5.65e+09$
 at $x = 0.$
 $y = 0.$

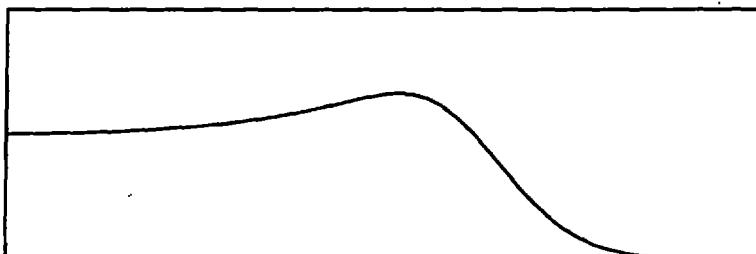


Fig. B2.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $5.00e-01$ keV

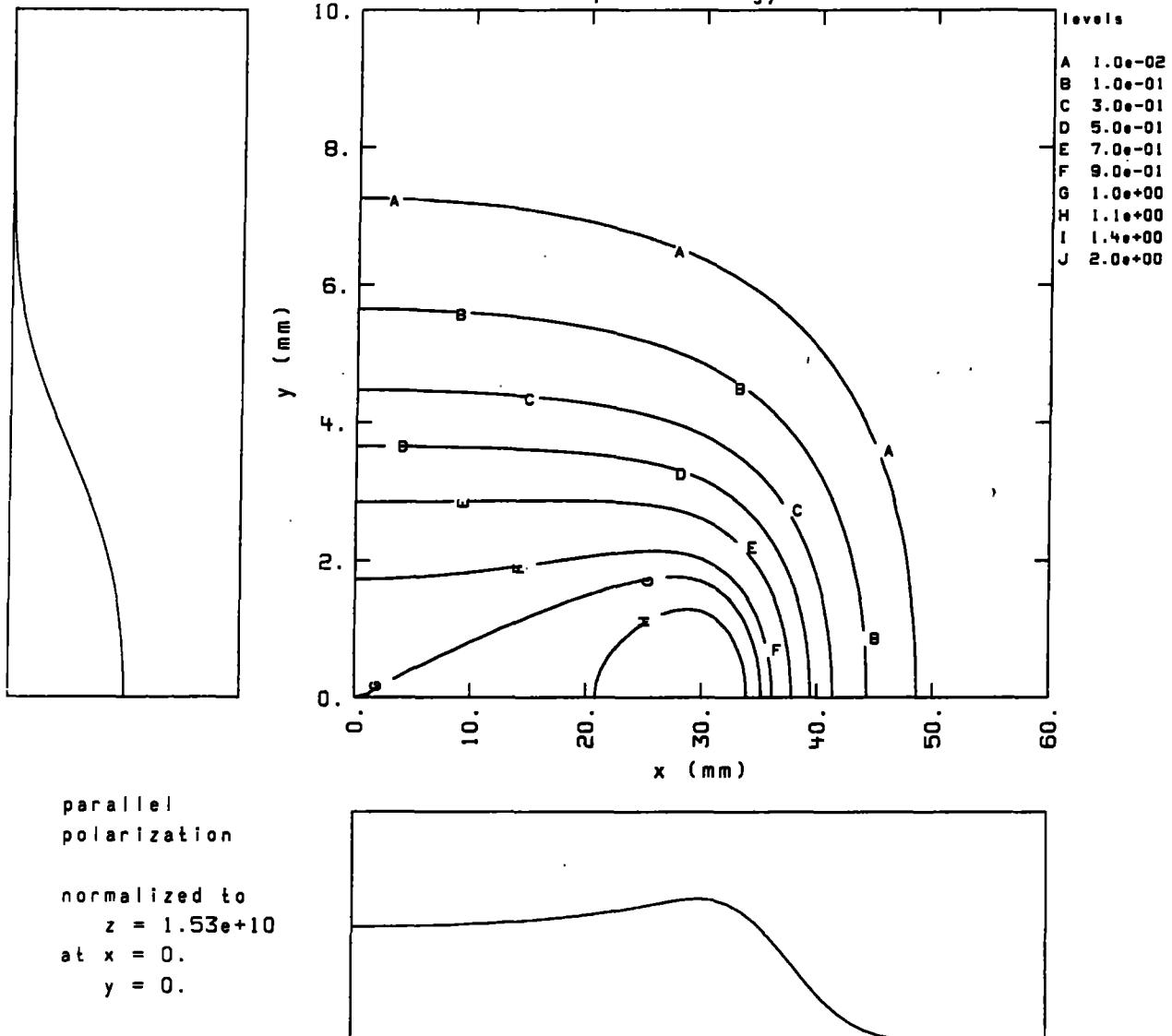
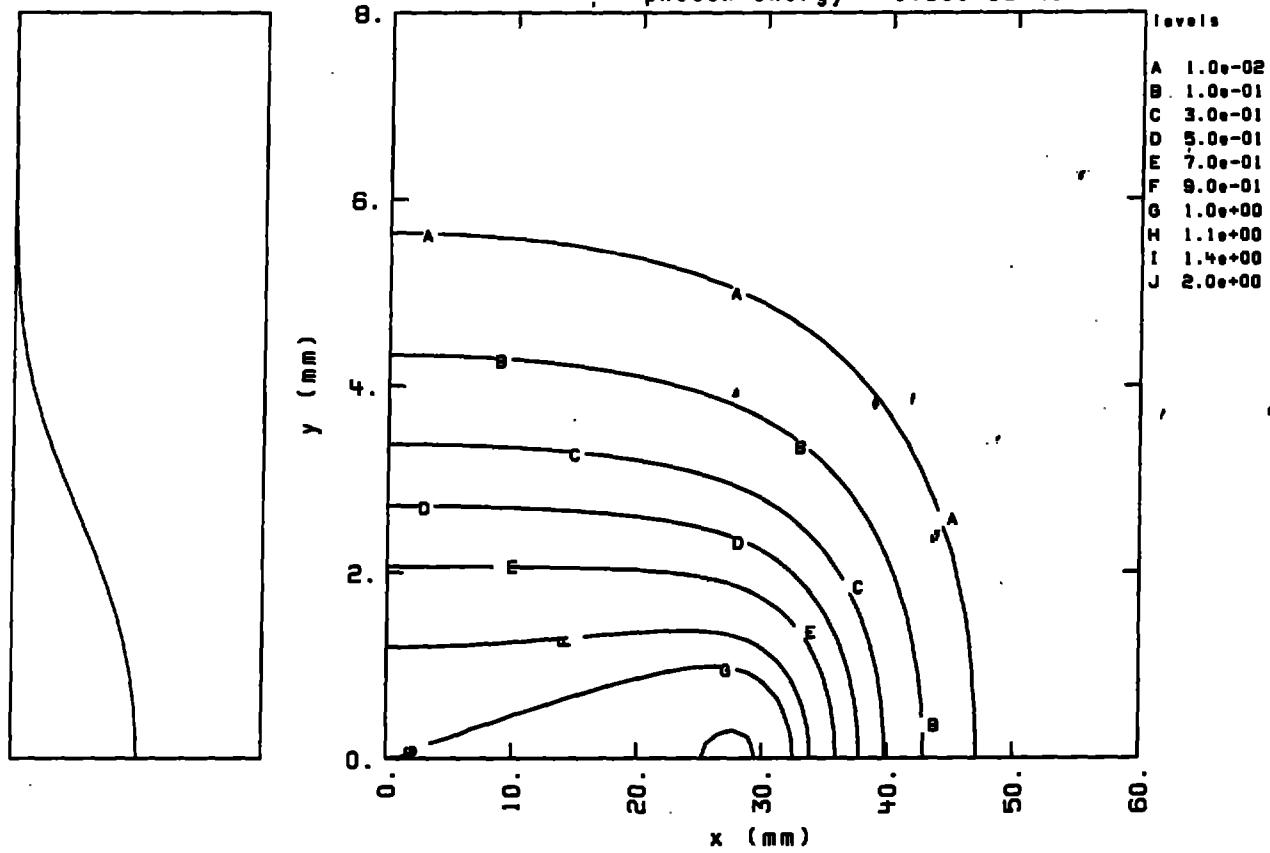


Fig. B2.3.

wiggler: 30 poles; $\theta = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e+00$ keV



parallel
polarization

 normalized to
 $z = 2.16e+10$
 at $x = 0.$
 $y = 0.$

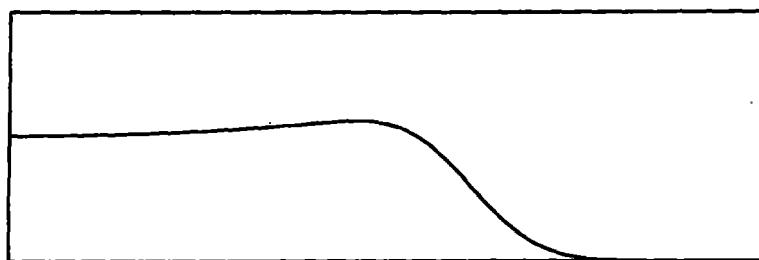


Fig. B2.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.40e+00$ keV

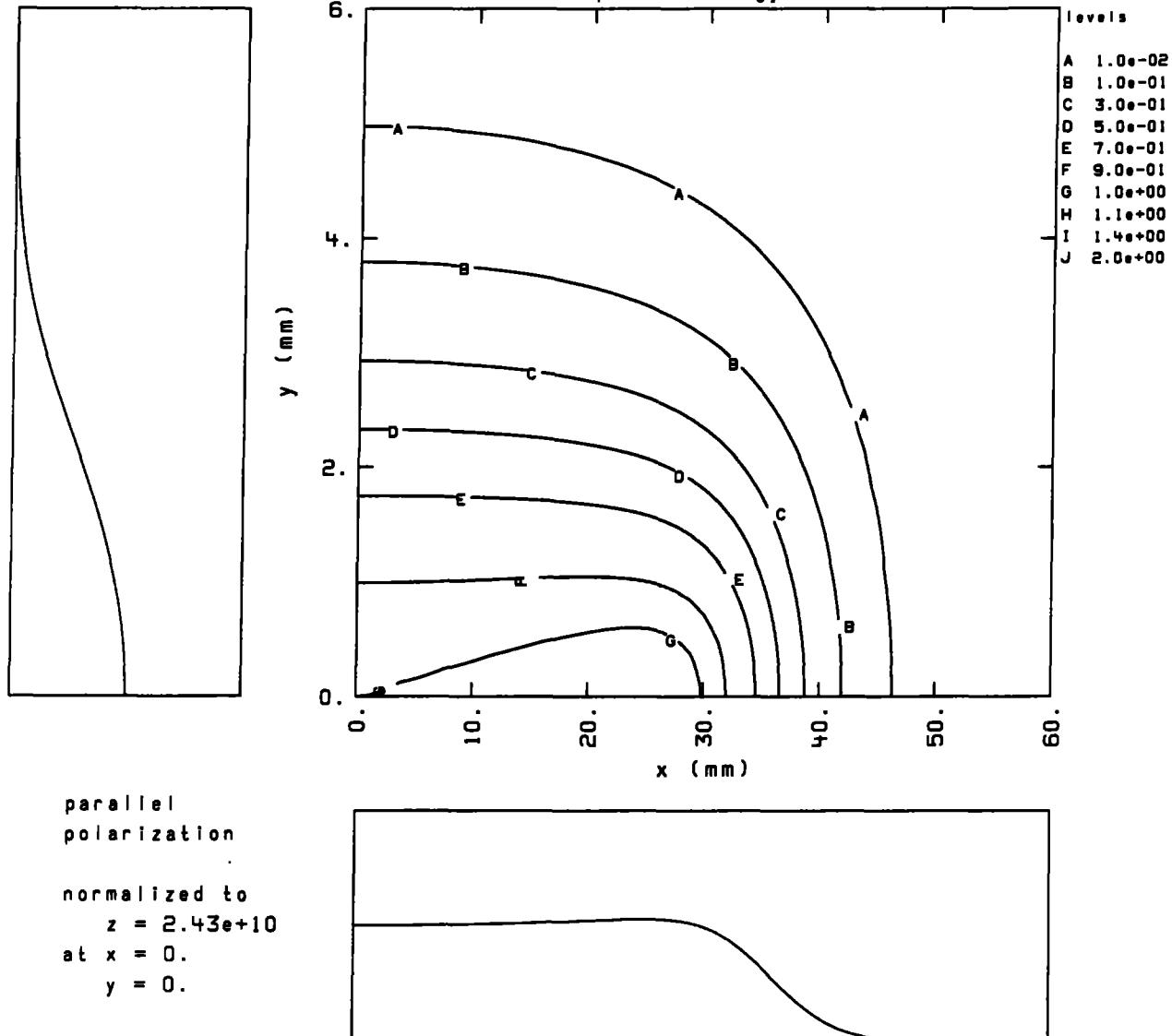
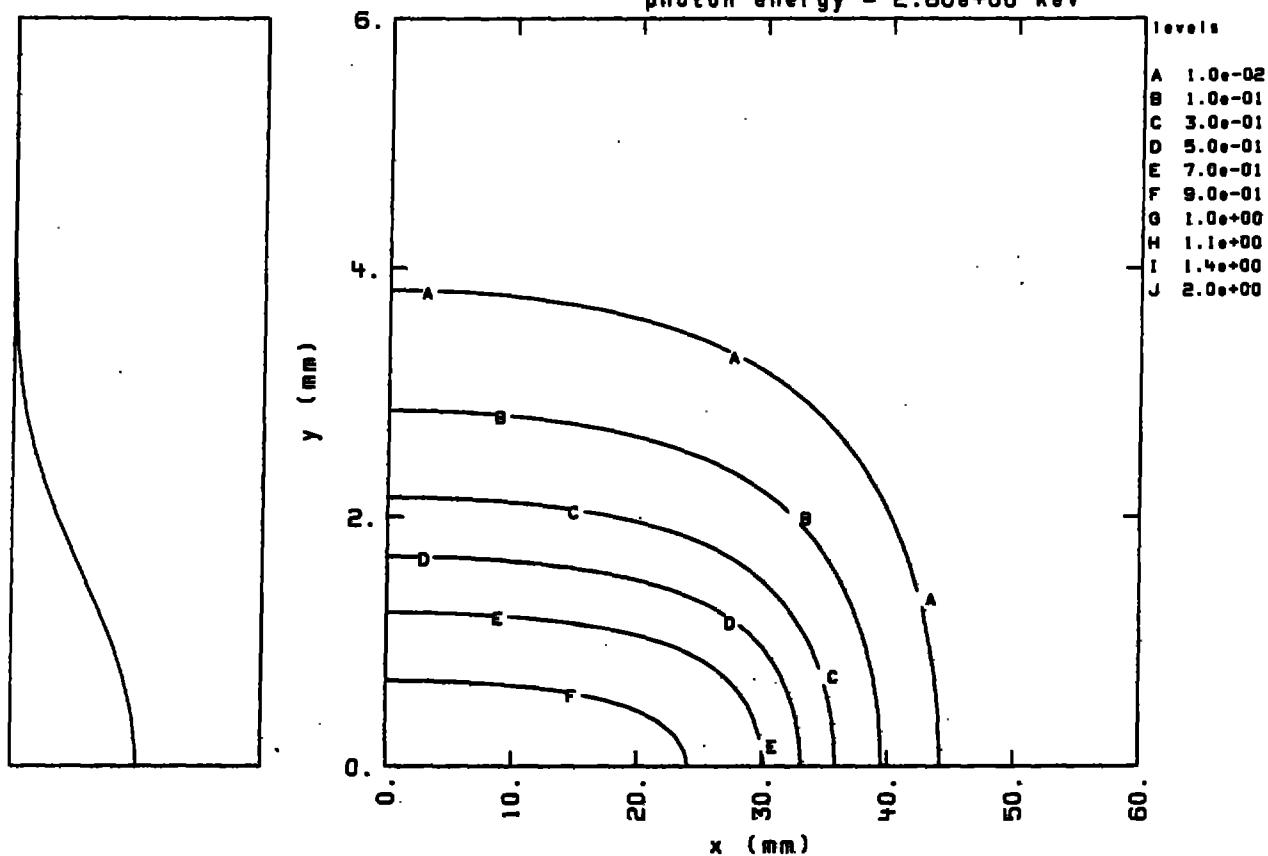


Fig. B2.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 1.80×10^0 GeV critical energy = 2.80×10^0 keV
 photon energy = 2.80×10^0 keV



parallel
polarization

normalized to
 $z = 2.57 \times 10^0$
 at $x = 0.$
 $y = 0.$

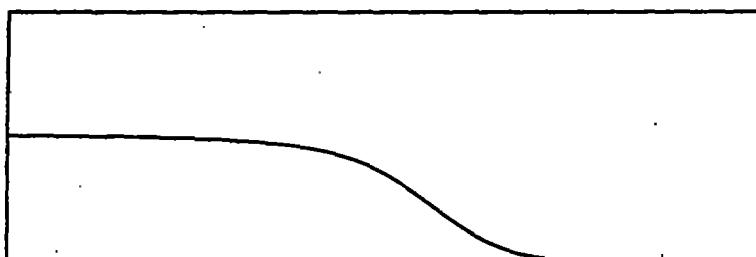


Fig. B2.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 1.80×10^0 GeV critical energy = 2.80×10^0 keV
 photon energy = 1.40×10^1 keV

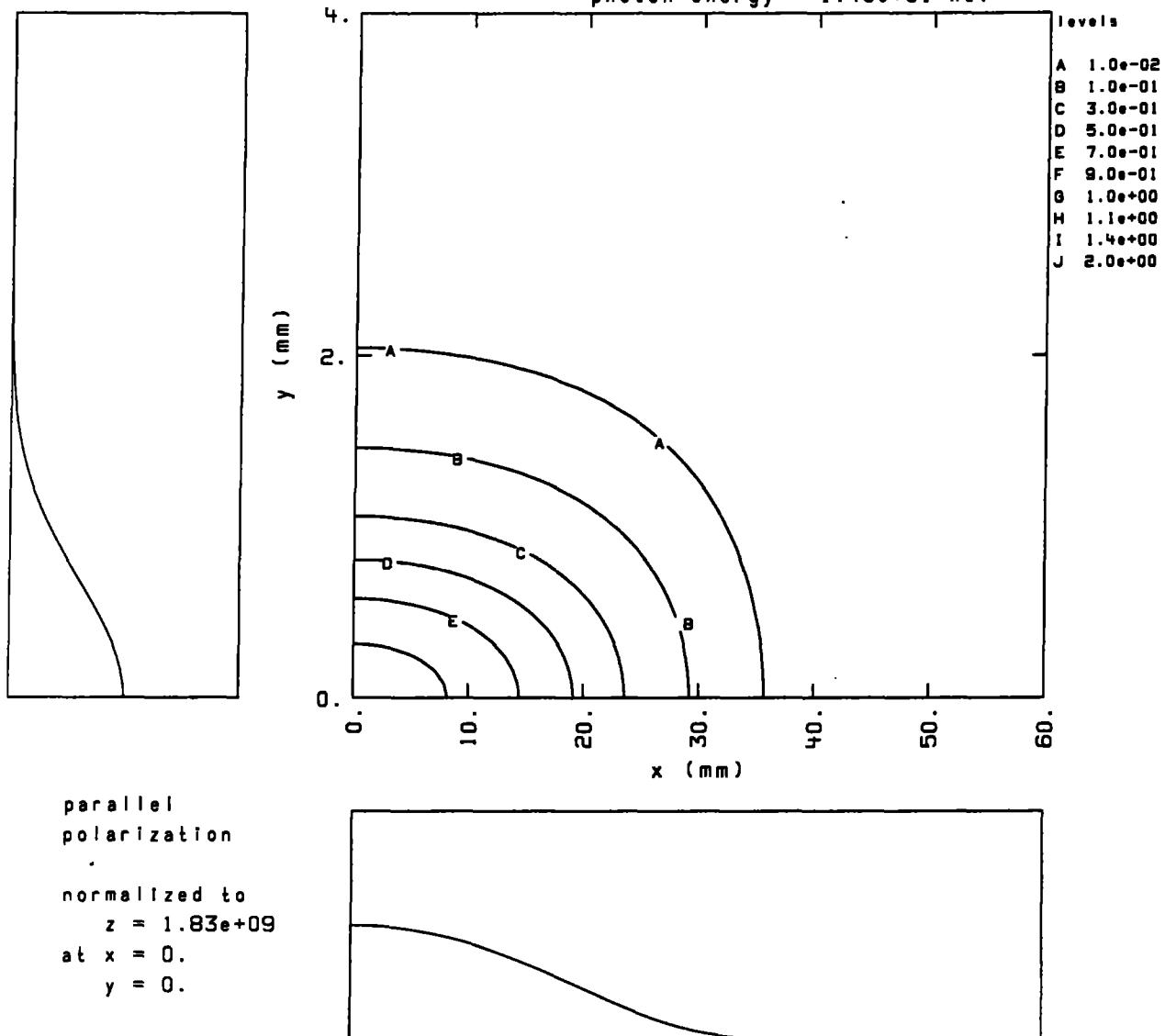
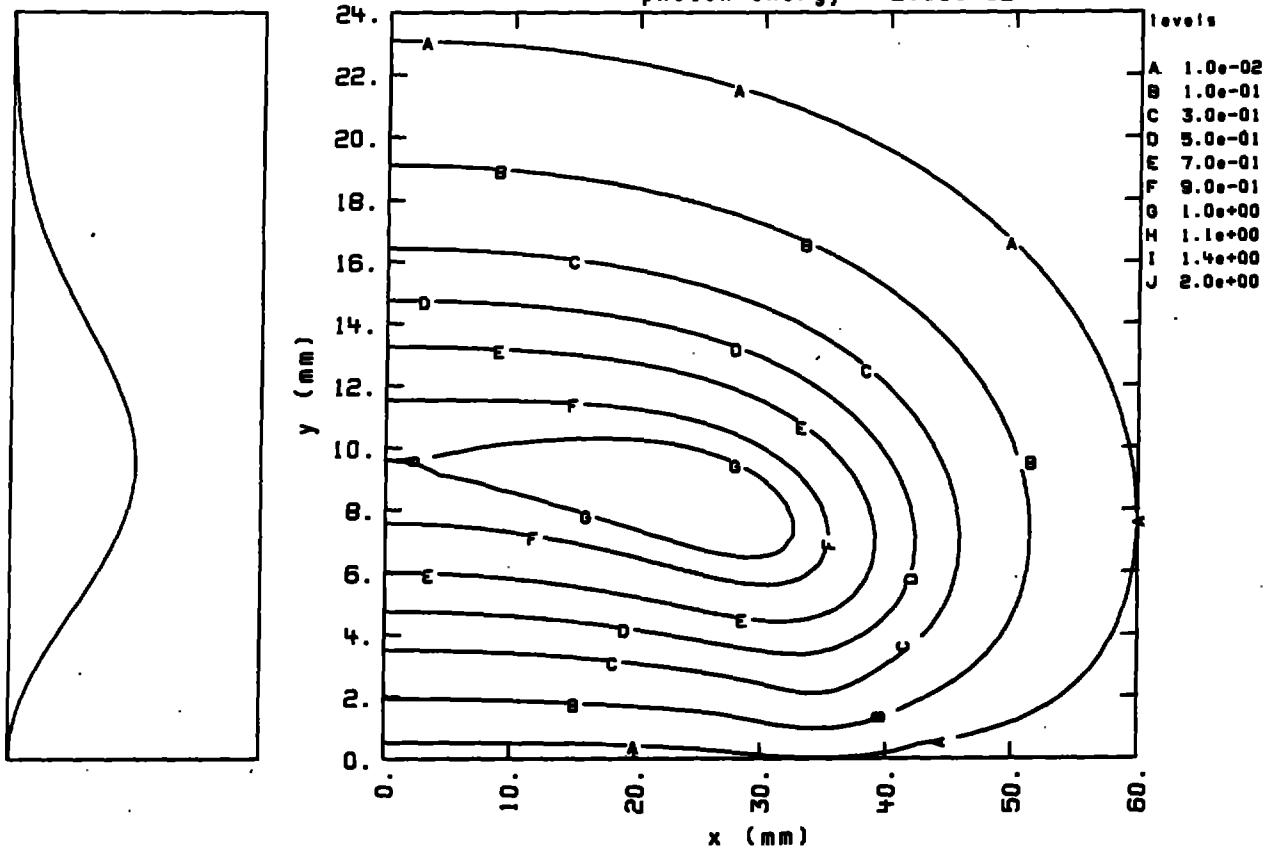


Fig. B2.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $2.00e-02$ keV



perpendicular
polarization

normalized to
 $z = 7.25e+08$
 at $x = 0$.
 $y = 9.60e+00$

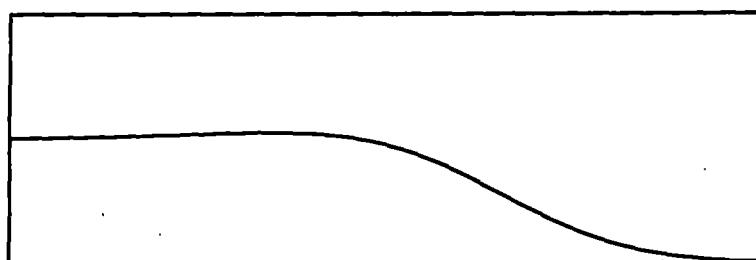
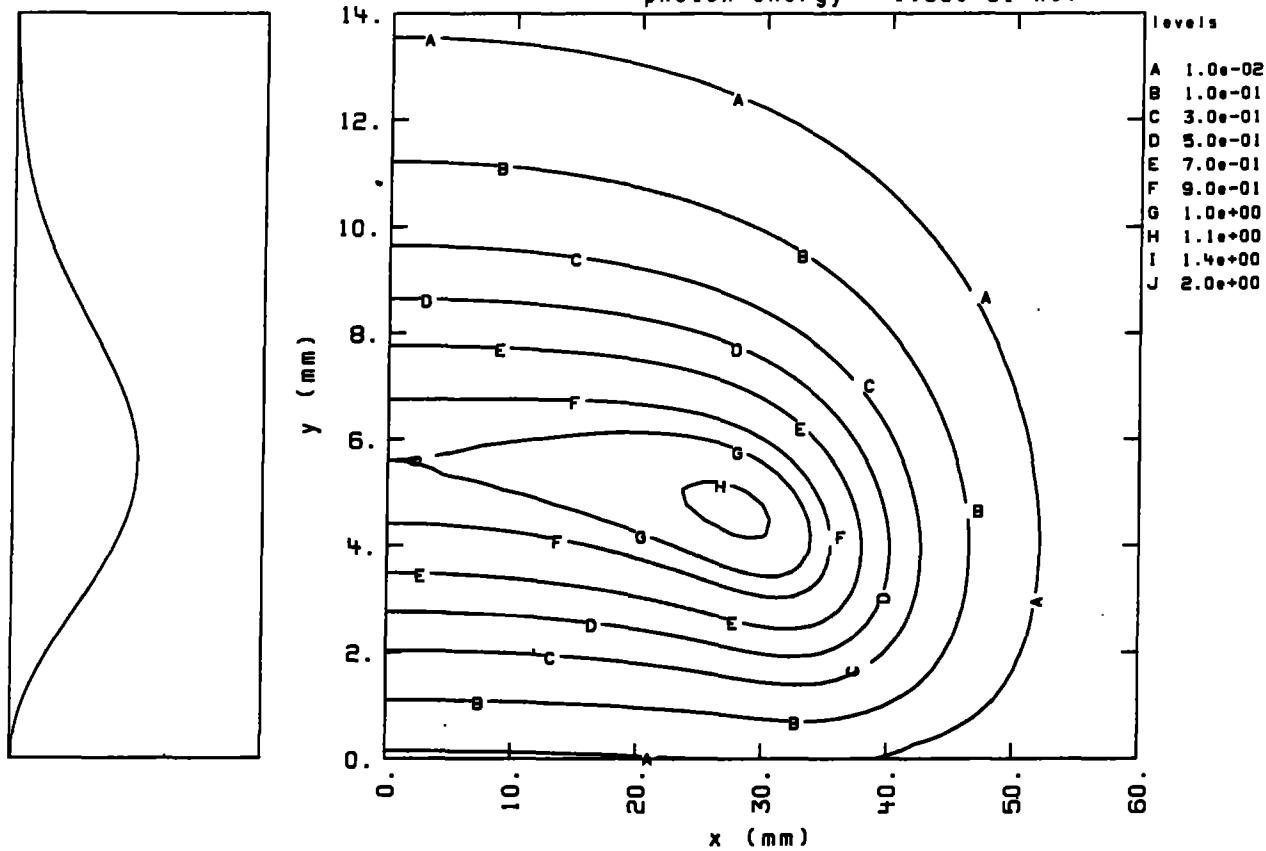


Fig. B3.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e-01$ keV



perpendicular
polarization

normalized to
 $z = 1.88e+09$
 at $x = 0$.
 $y = 5.60e+00$

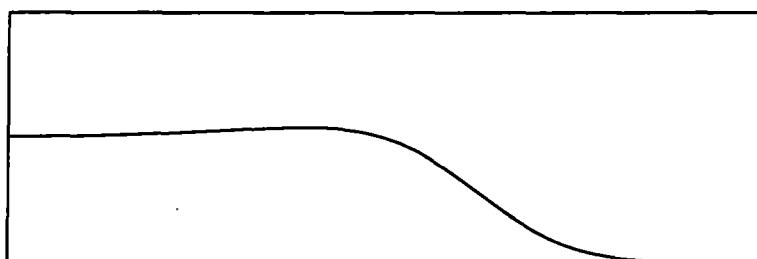
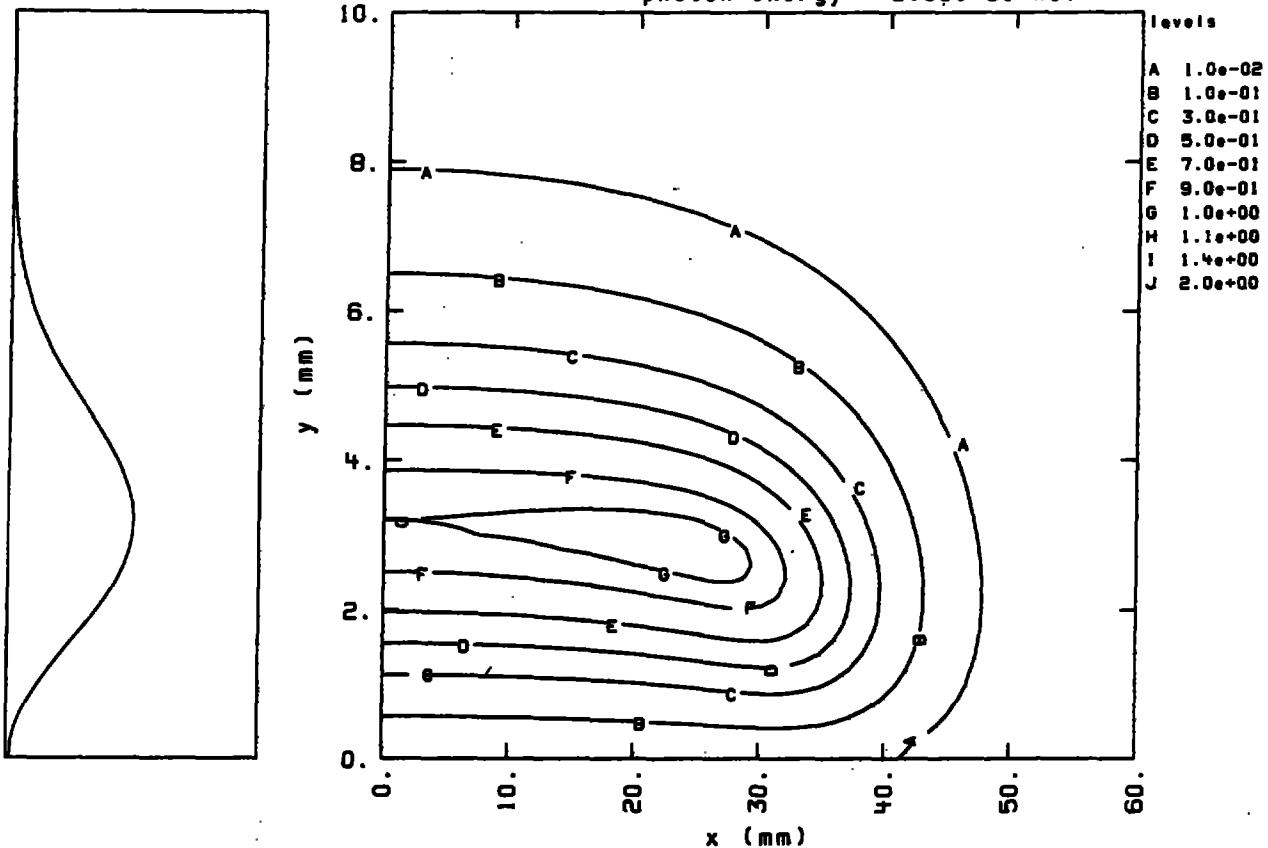


Fig. B3.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $5.00e-01$ keV



perpendicular
polarization

normalized to
 $z = 3.79e+09$
 at $x = 0.$
 $y = 3.20e+00$

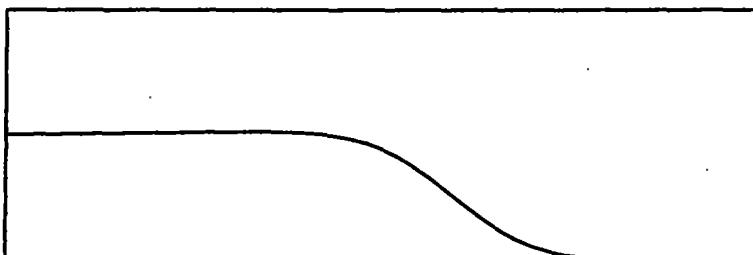
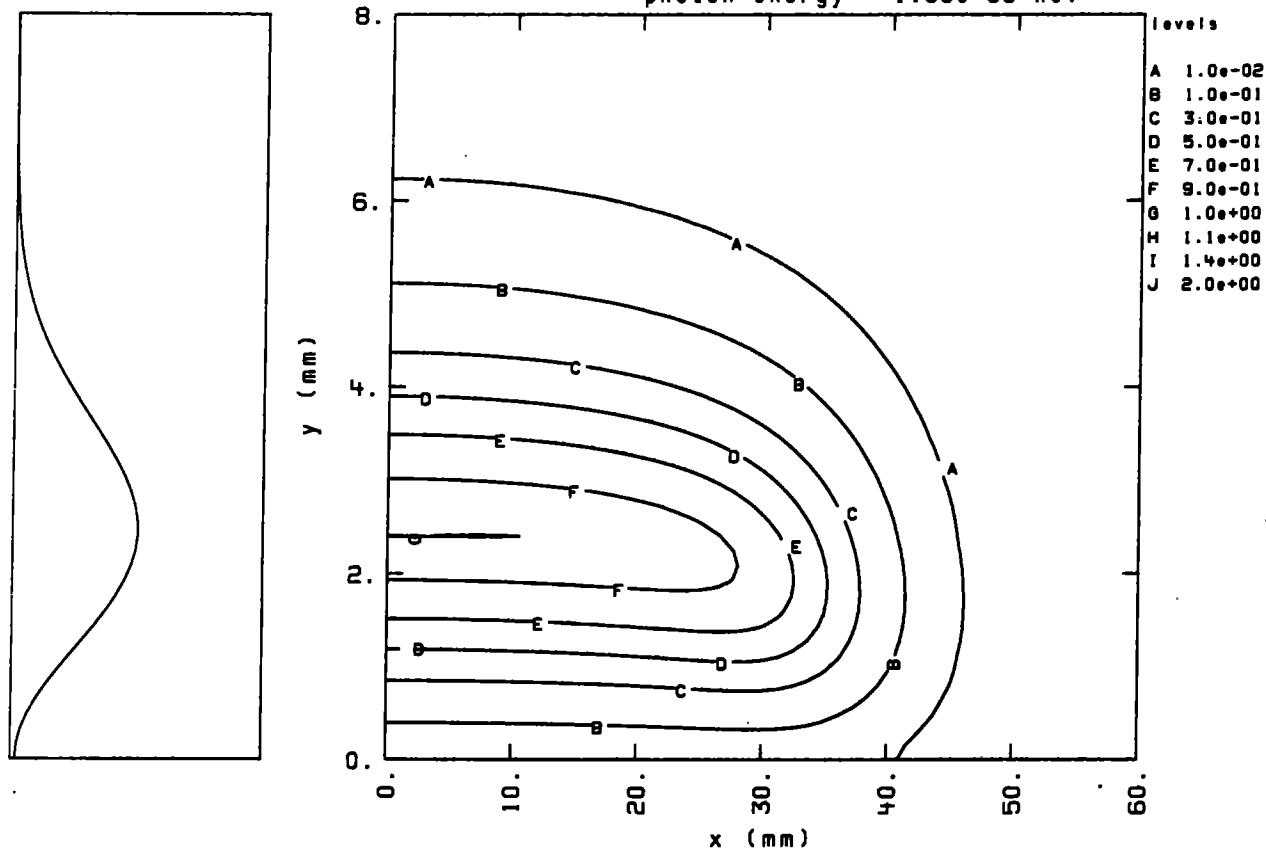


Fig. B3.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e+00$ keV



perpendicular
polarization

normalized to
 $z = 4.24e+09$
 at $x = 0.$
 $y = 2.40e+00$

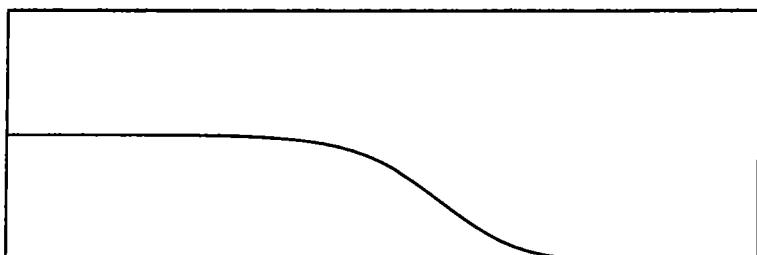


Fig. B3.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.40e+00$ keV

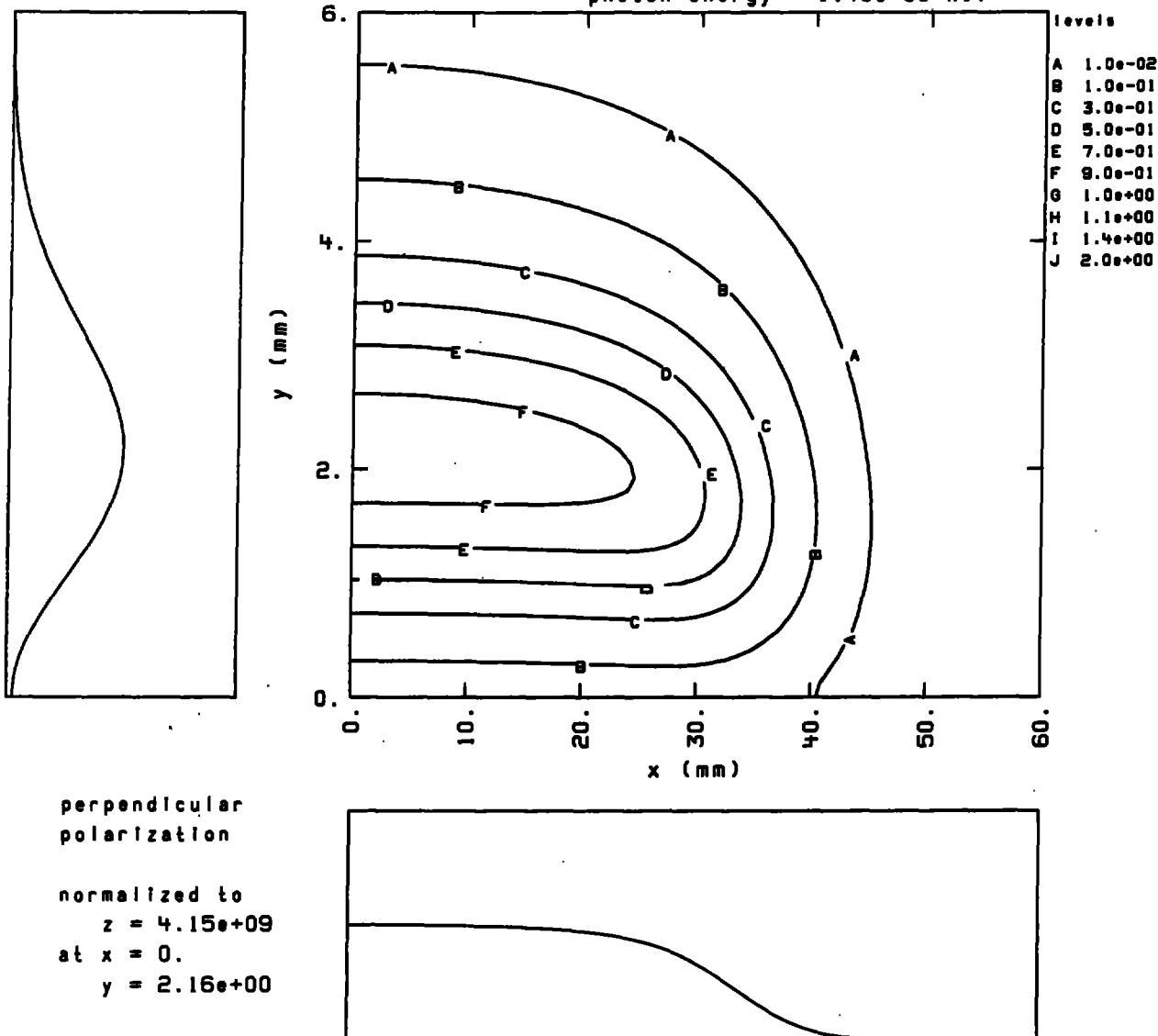


Fig. B3.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $2.80e+00$ keV

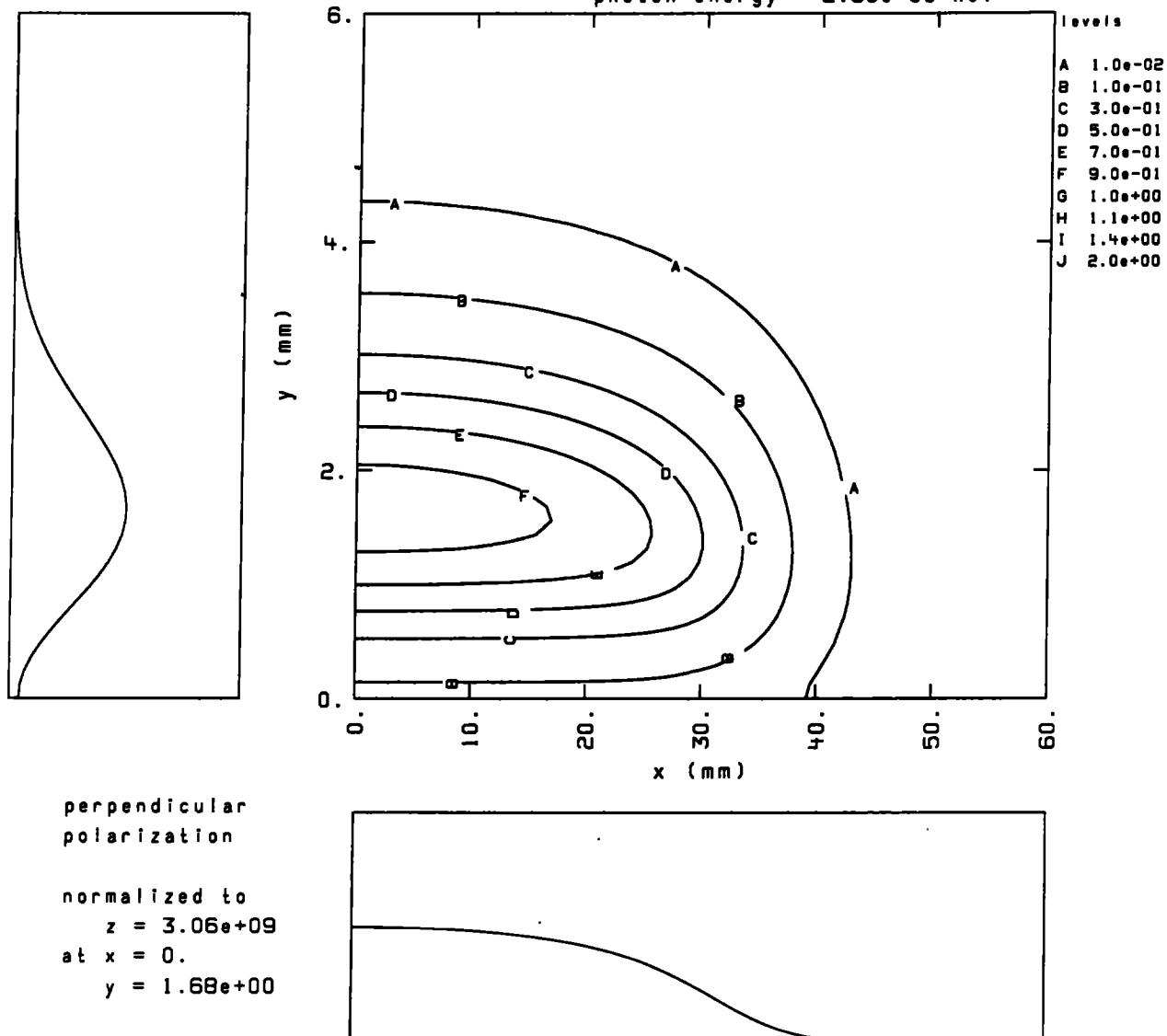


Fig. B3.6.

wiggler:: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.40e+01$ keV

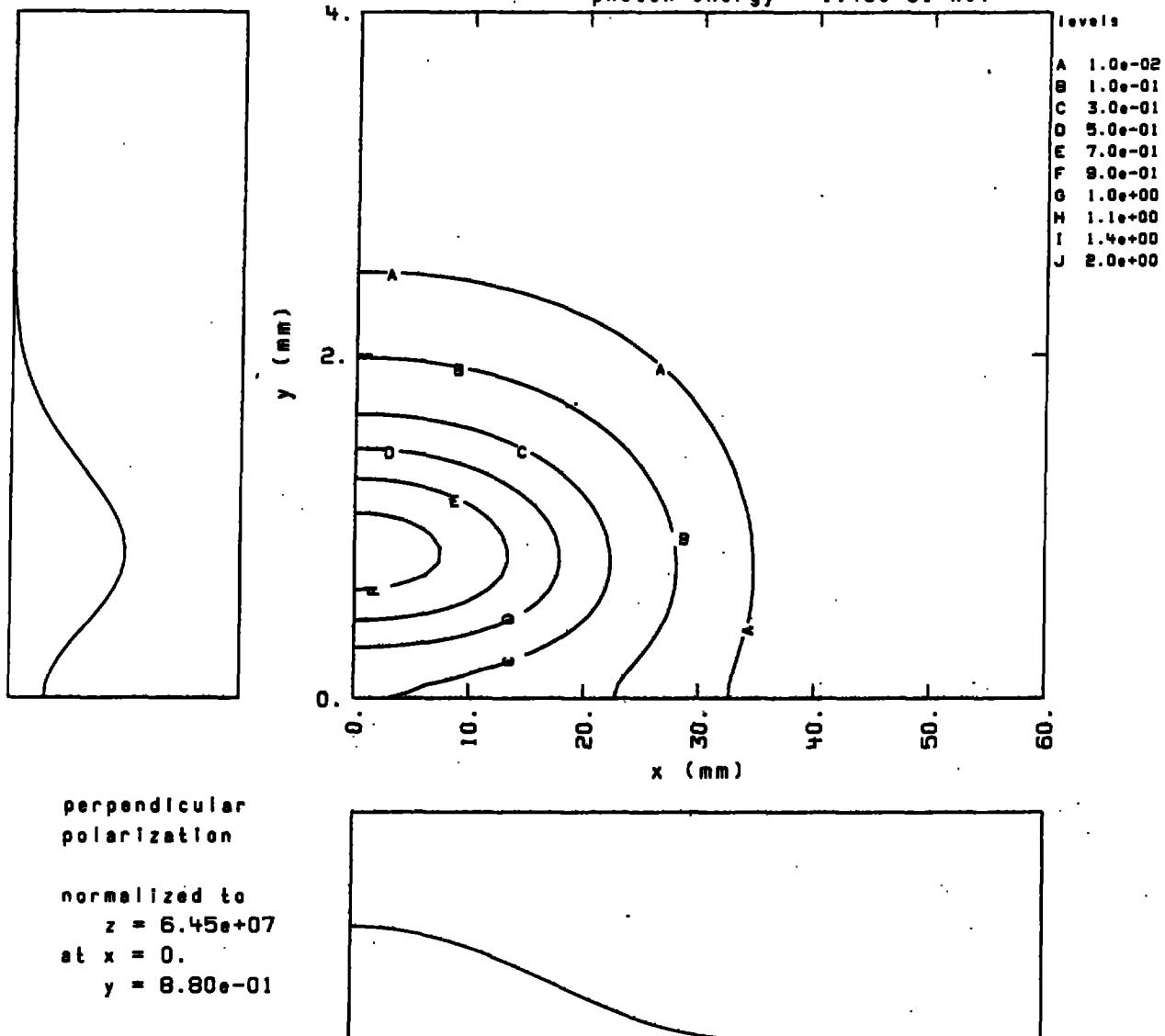
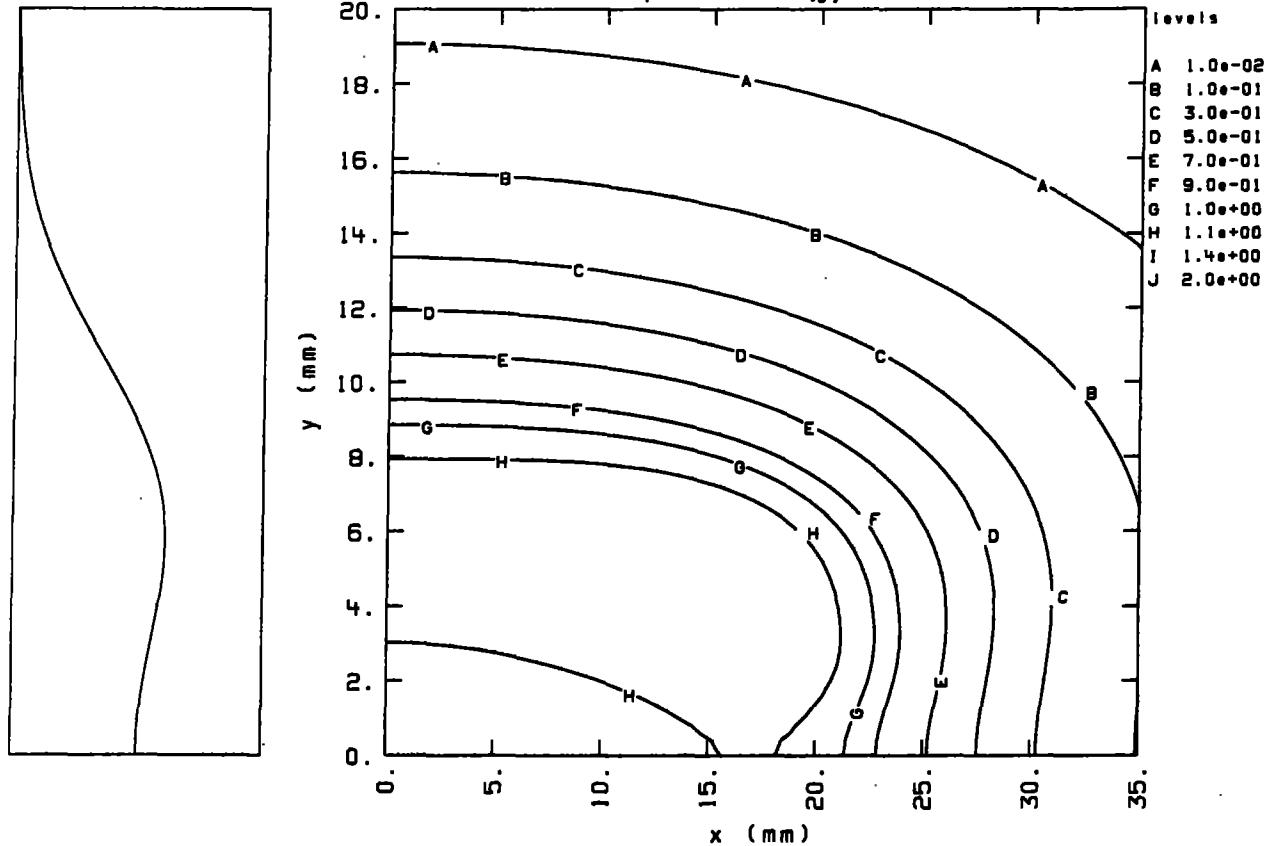


Fig. B3.7

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.00×10^0 GeV critical energy = 7.78×10^0 keV
 photon energy = 2.00×10^{-2} keV



normalized to
 $z = 2.73 \times 10^9$
 at $x = 0$.
 $y = 0$.

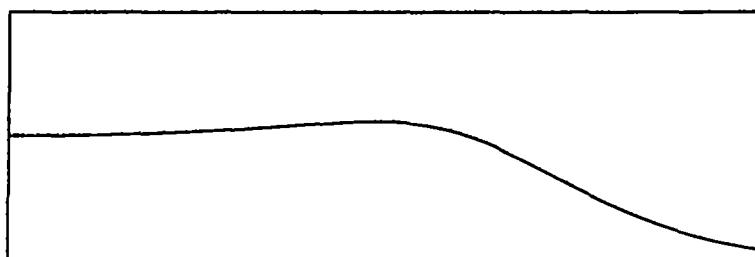
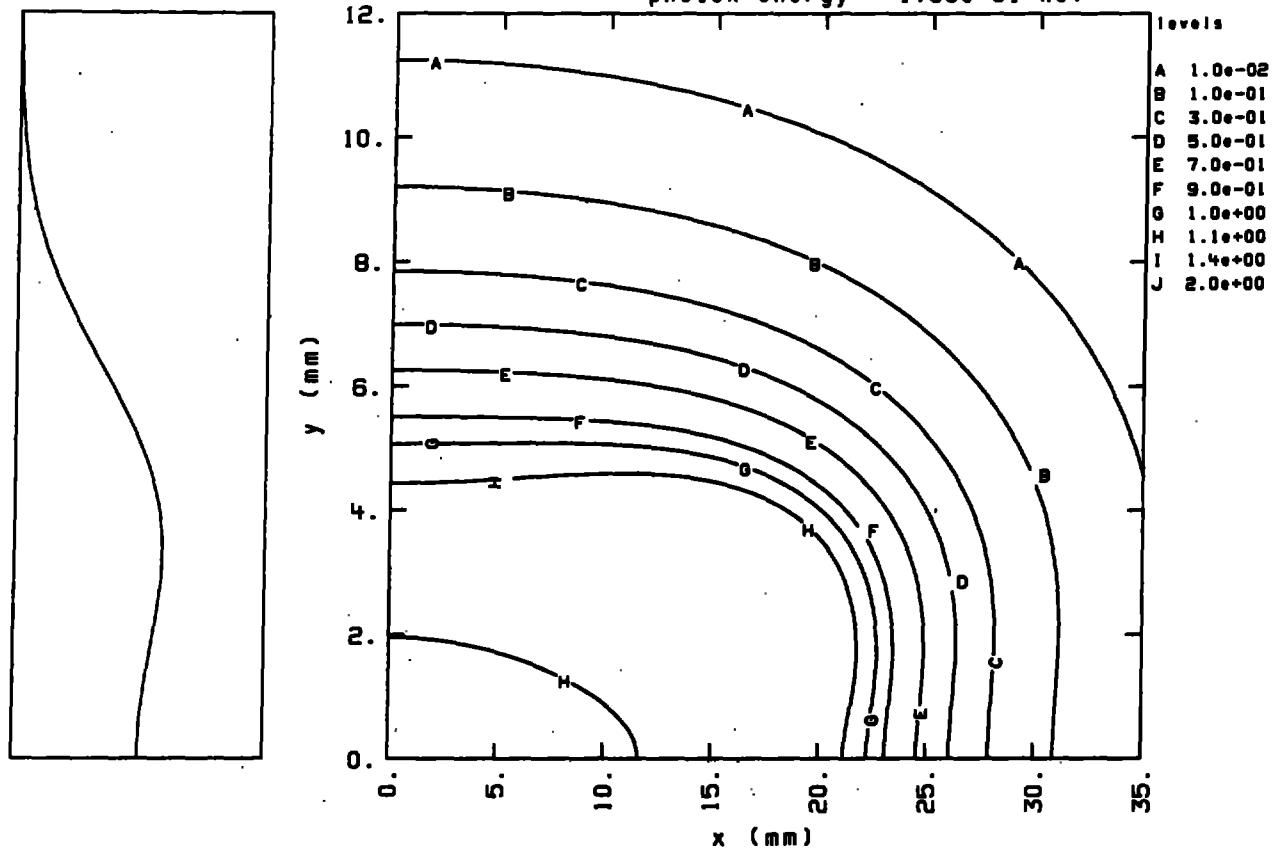


Fig. B4.1

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $1.00e-01$ keV



normalized to
 $z = 8.05e+09$
 at $x = 0.$
 $y = 0.$

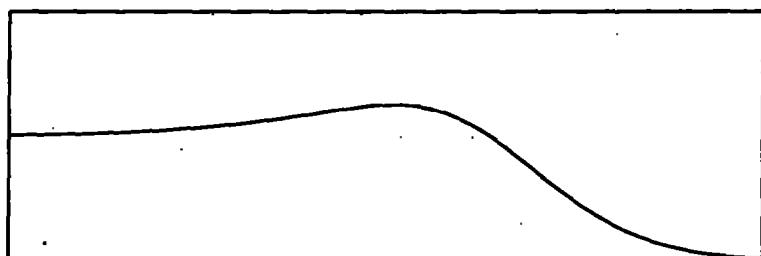
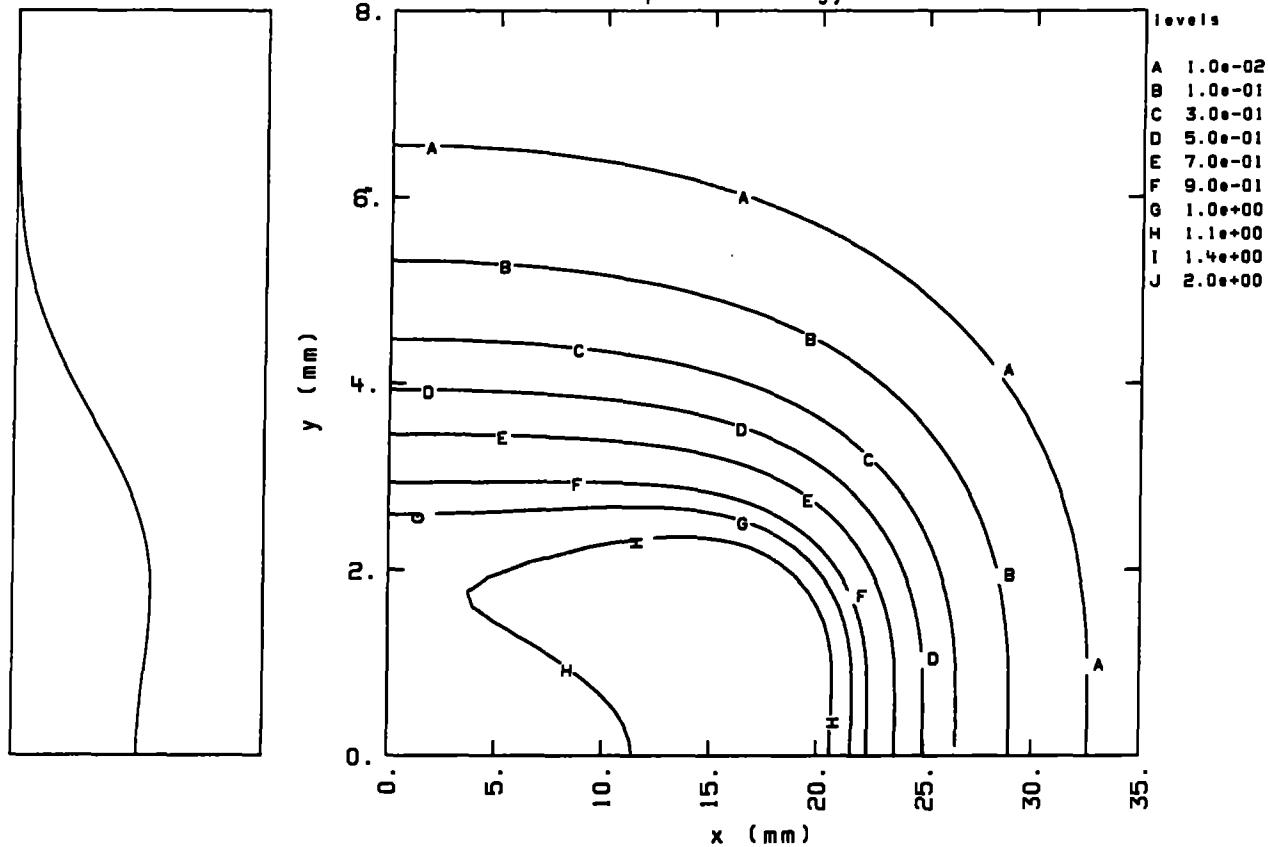


Fig. B4.2

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $5.00e-01$ keV



normalized to
 $z = 2.32e+10$
 at $x = 0.$
 $y = 0.$

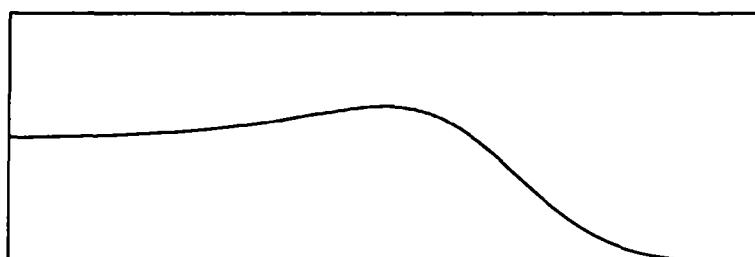
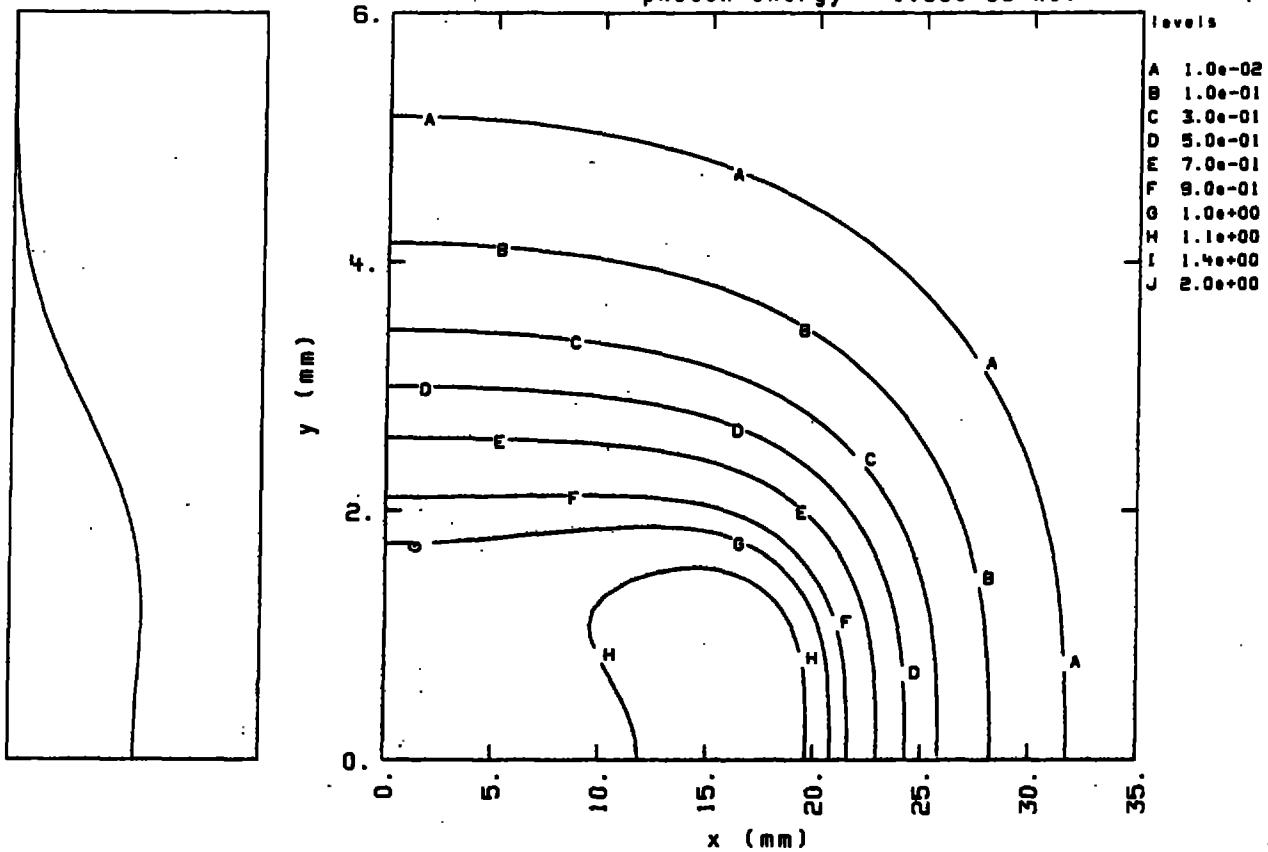


Fig. B4.3

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $1.00e+00$ keV



normalized to
 $z = 3.56e+10$
 at $x = 0.$
 $y = 0.$

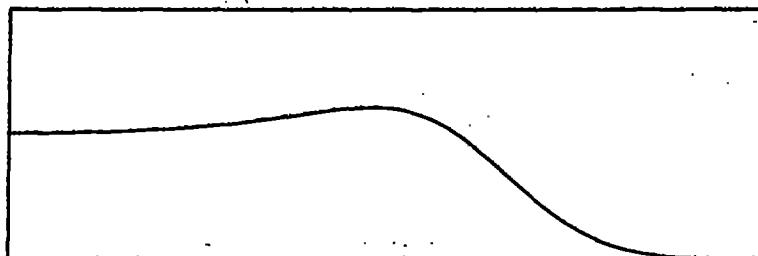
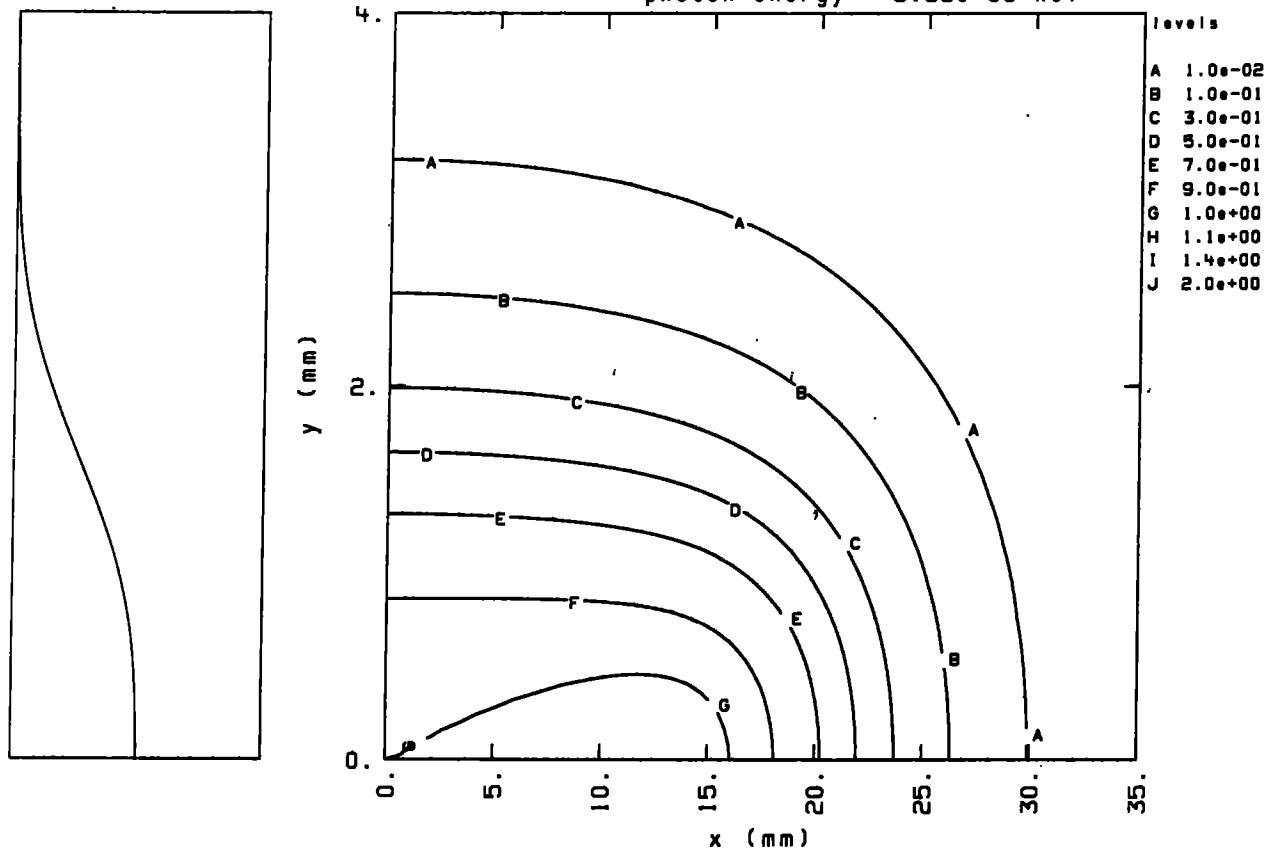


Fig. B4.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $3.89e+00$ keV



normalized to
 $z = 6.79e+10$
 at $x = 0.$
 $y = 0.$

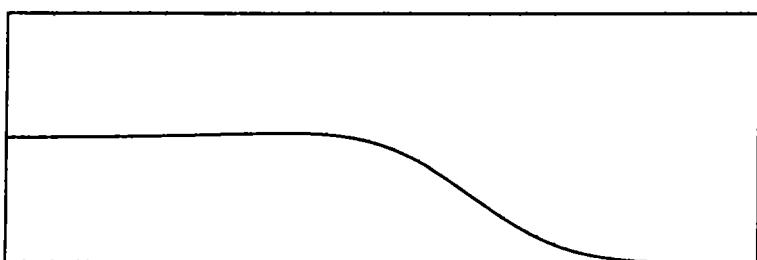
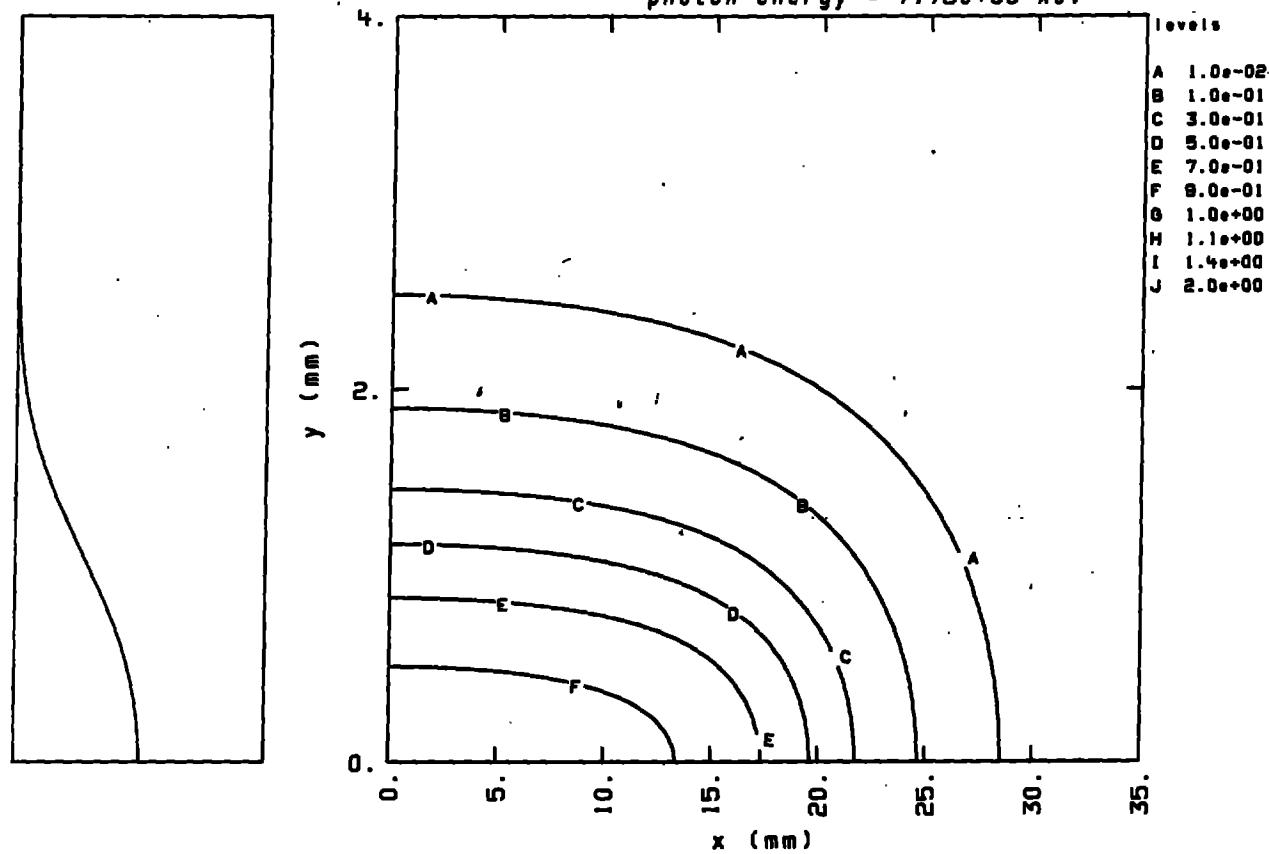


Fig. B4.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $7.78e+00$ keV



normalized to
 $z = 7.08e+10$
 at $x = 0.$
 $y = 0.$

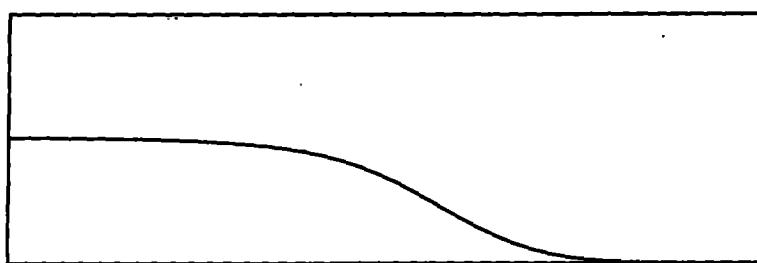
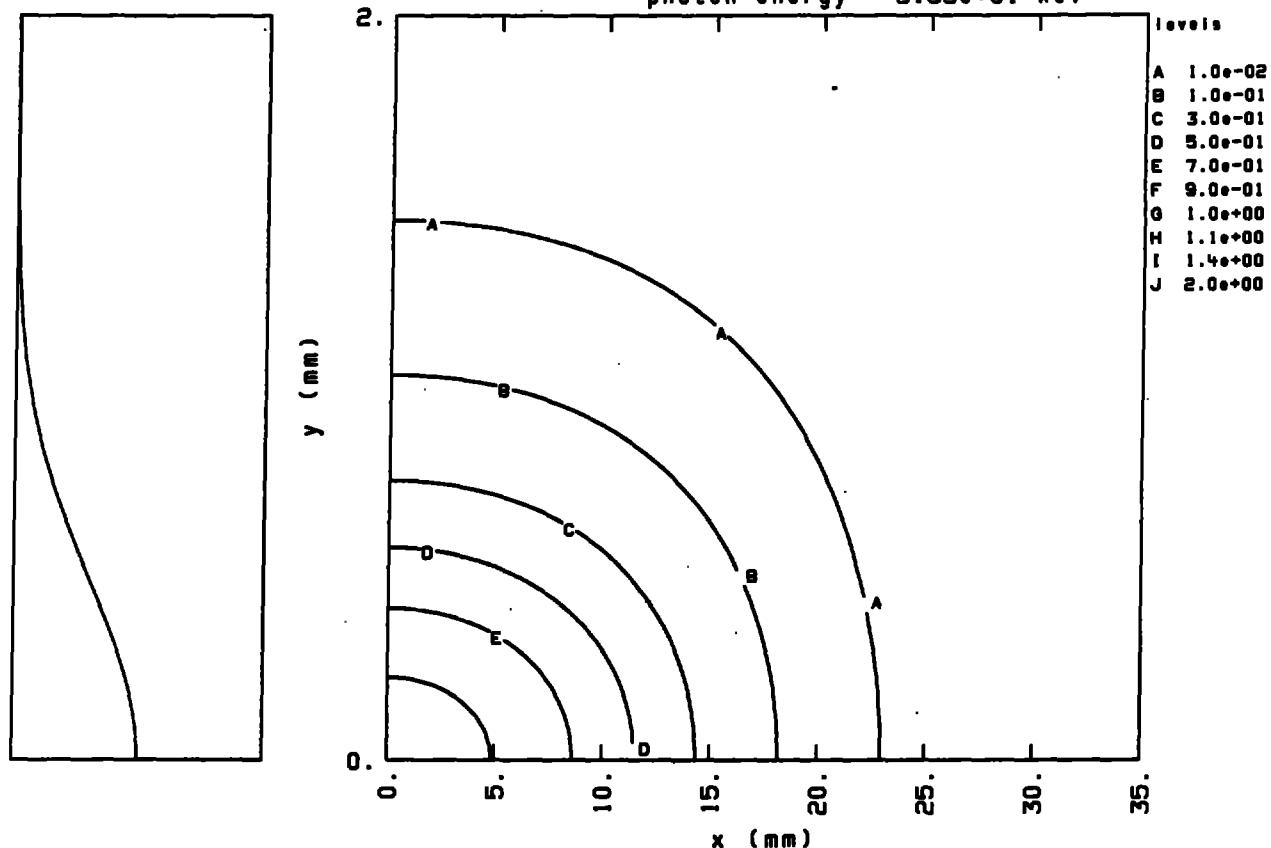


Fig. B4.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $3.89e+01$ keV



normalized to
 $z = 4.40e+09$
 at $x = 0.$
 $y = 0.$



Fig. B4.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.00×10^0 GeV critical energy = 7.78×10^0 keV
 photon energy = 2.00×10^{-2} keV

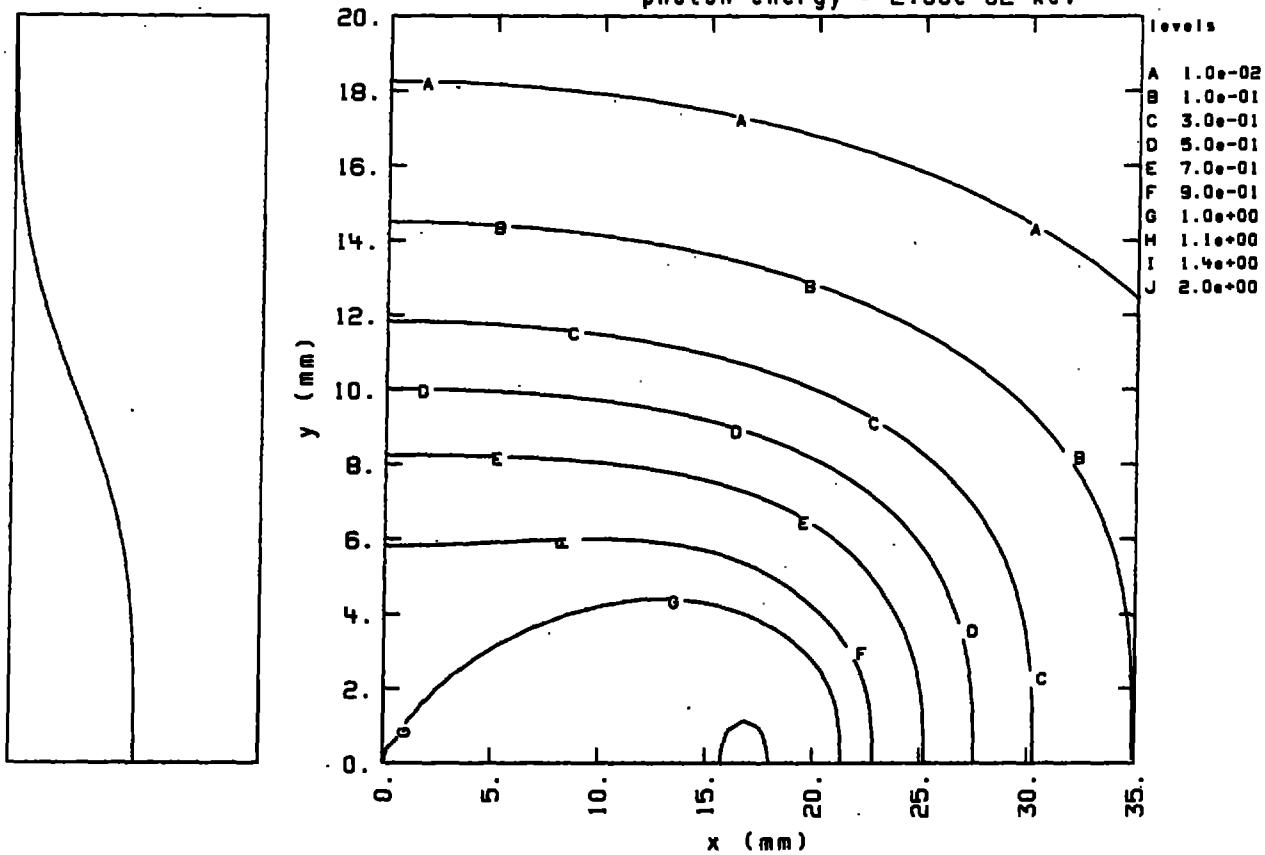
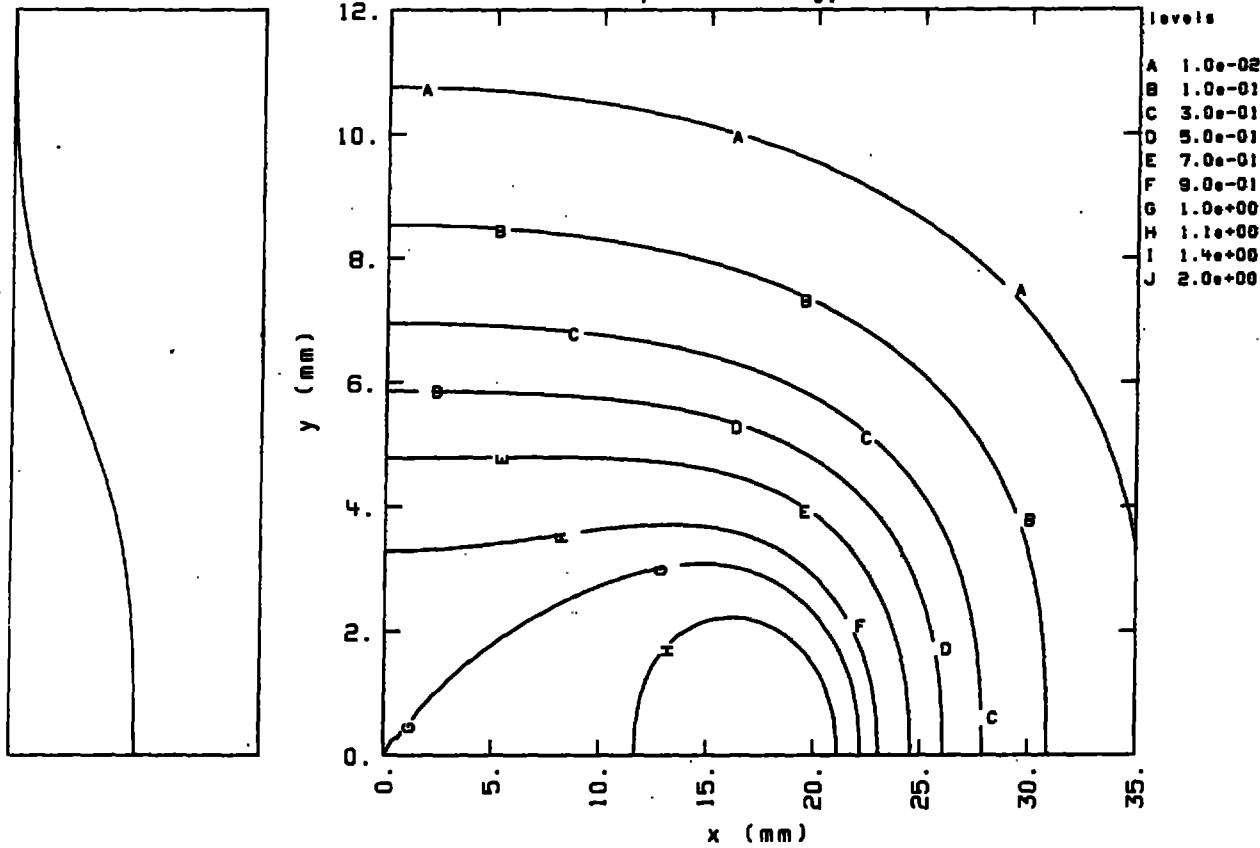


Fig. B5.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $1.00e-01$ keV



parallel
polarization

normalized to
 $z = 8.02e+09$
 at $x = 0.$
 $y = 0.$

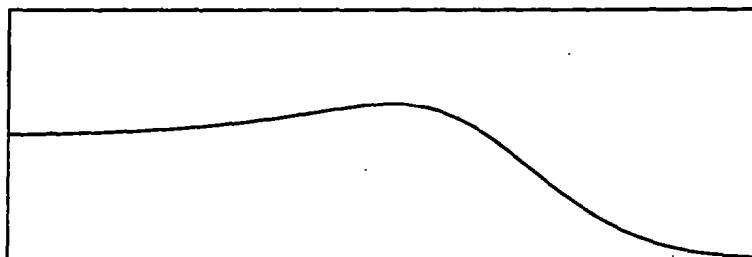
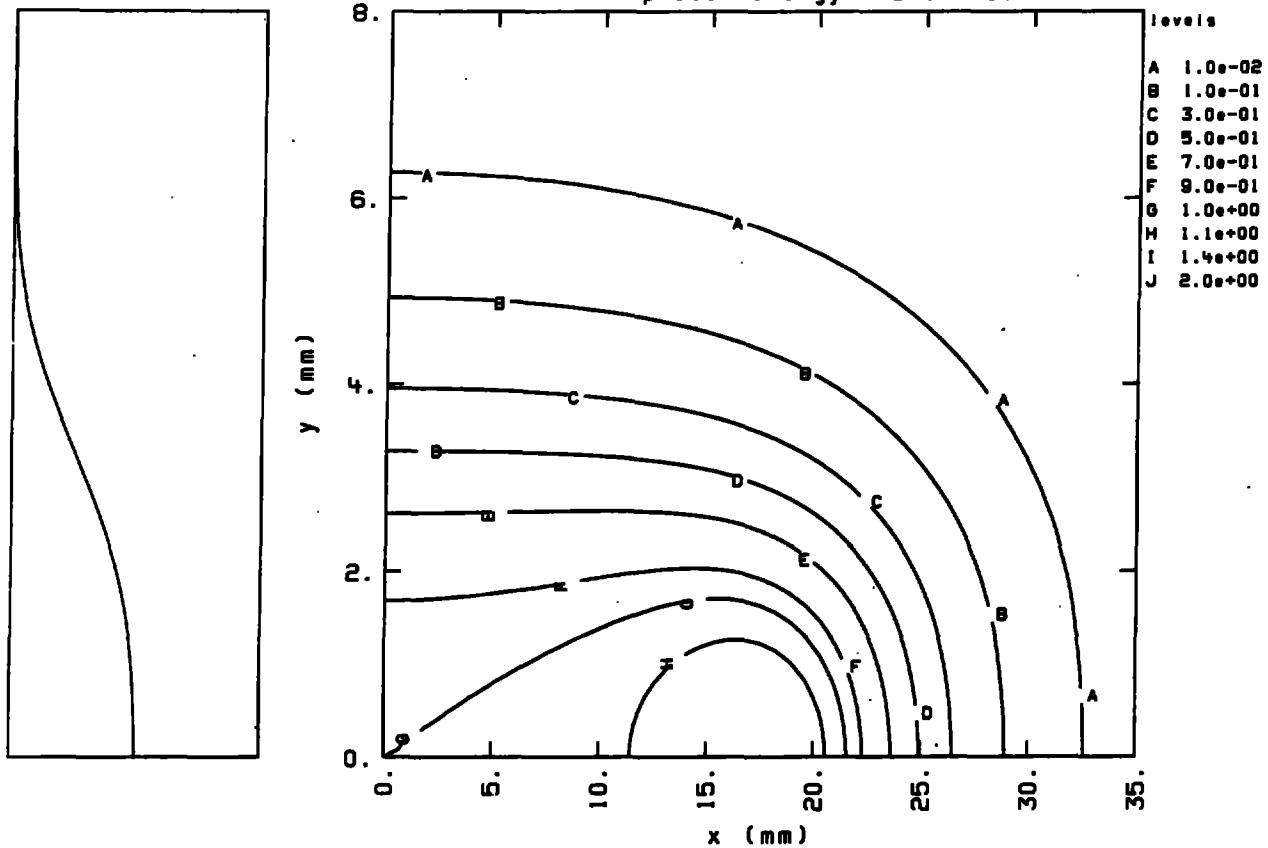


Fig. B5.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $5.00e-01$ keV



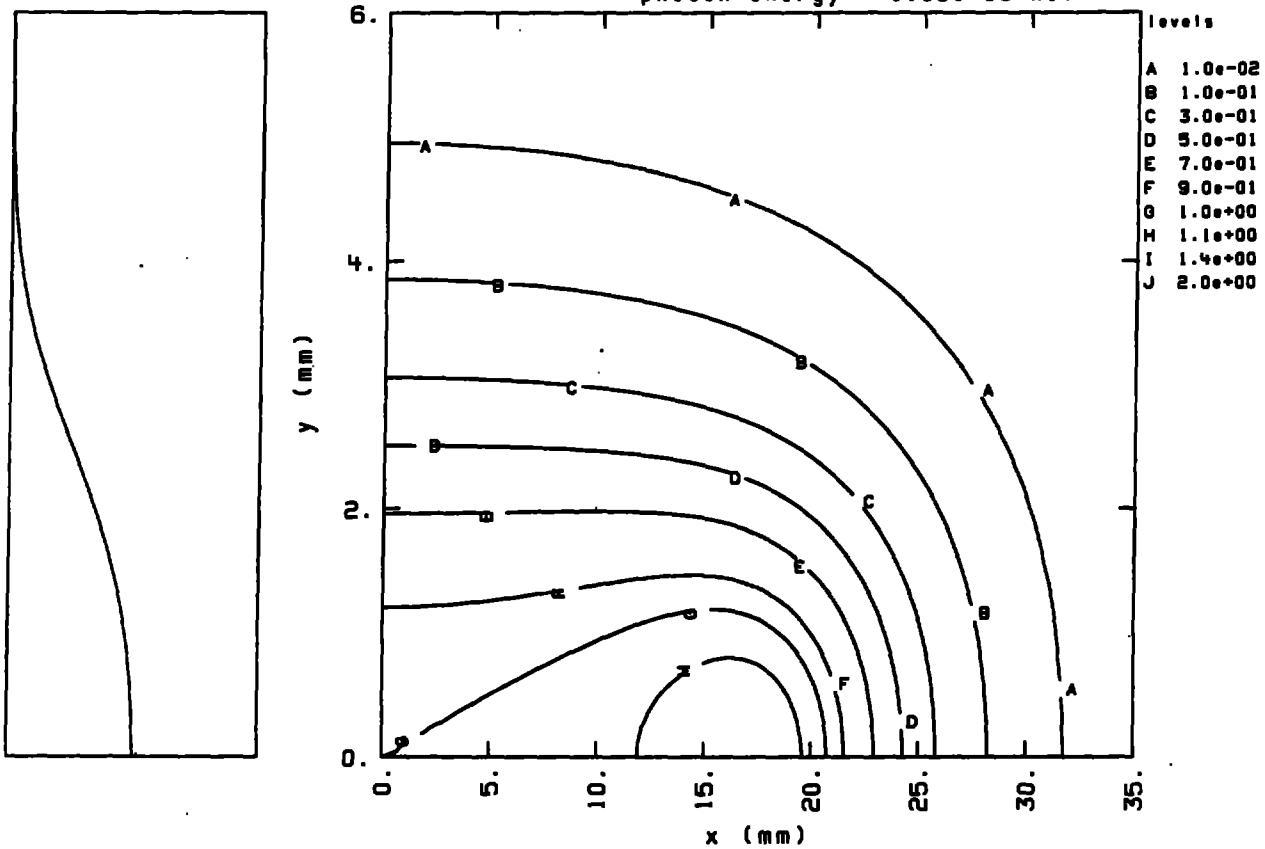
parallel
polarization

normalized to
 $z = 2.30e+10$
 at $x = 0$.
 $y = 0$.



Fig. B5.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $1.00e+00$ keV



parallel
polarization

normalized to
 $z = 3.52e+10$
 at $x = 0.$
 $y = 0.$

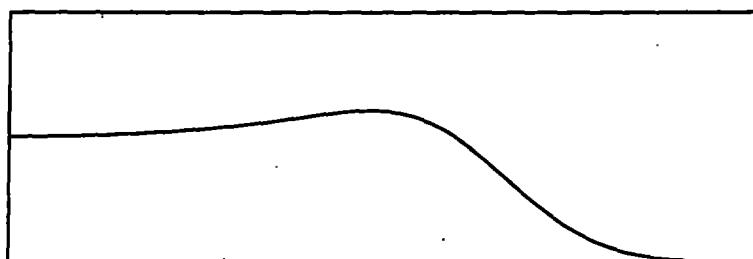


Fig. B5.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $3.89e+00$ keV

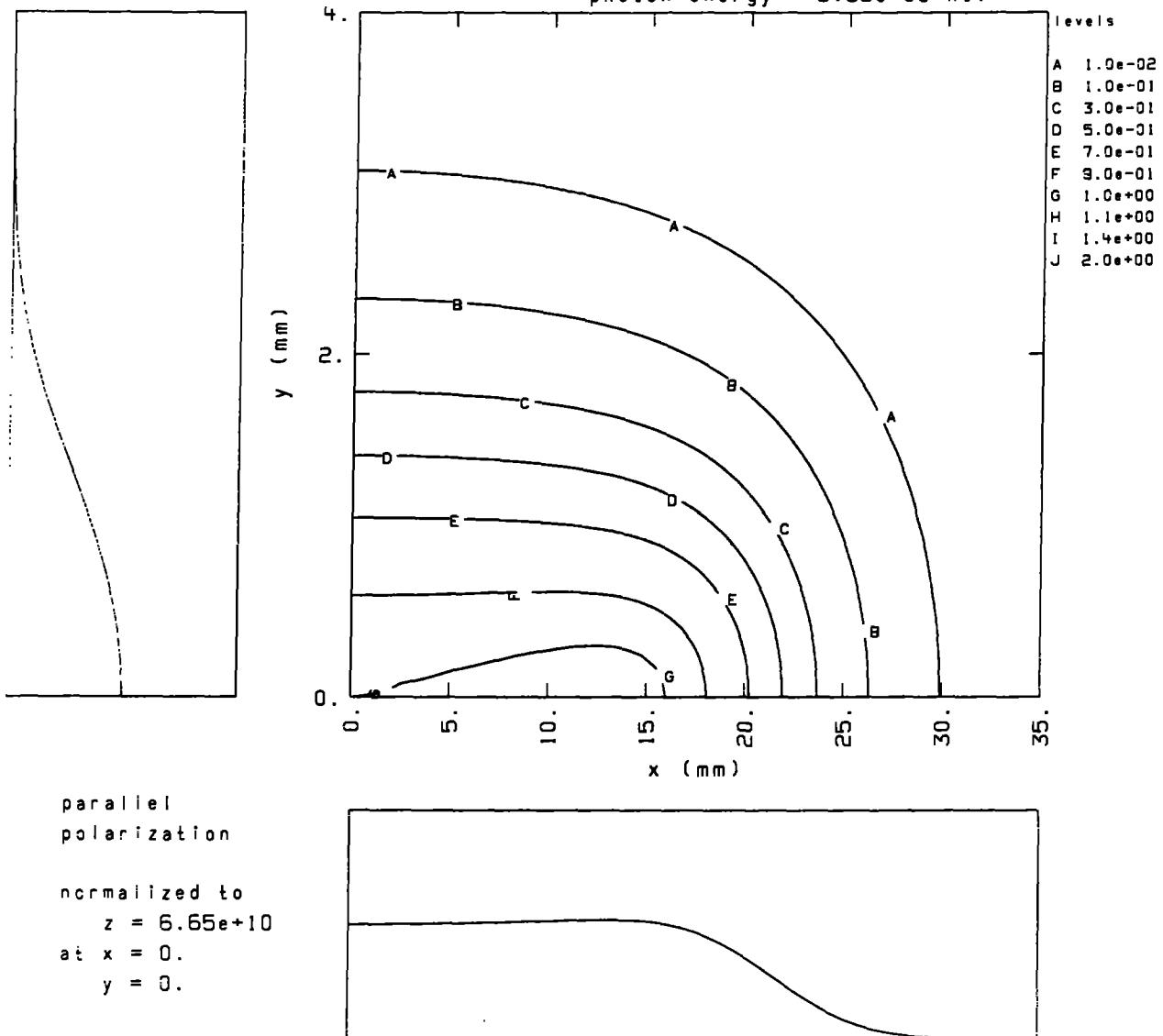
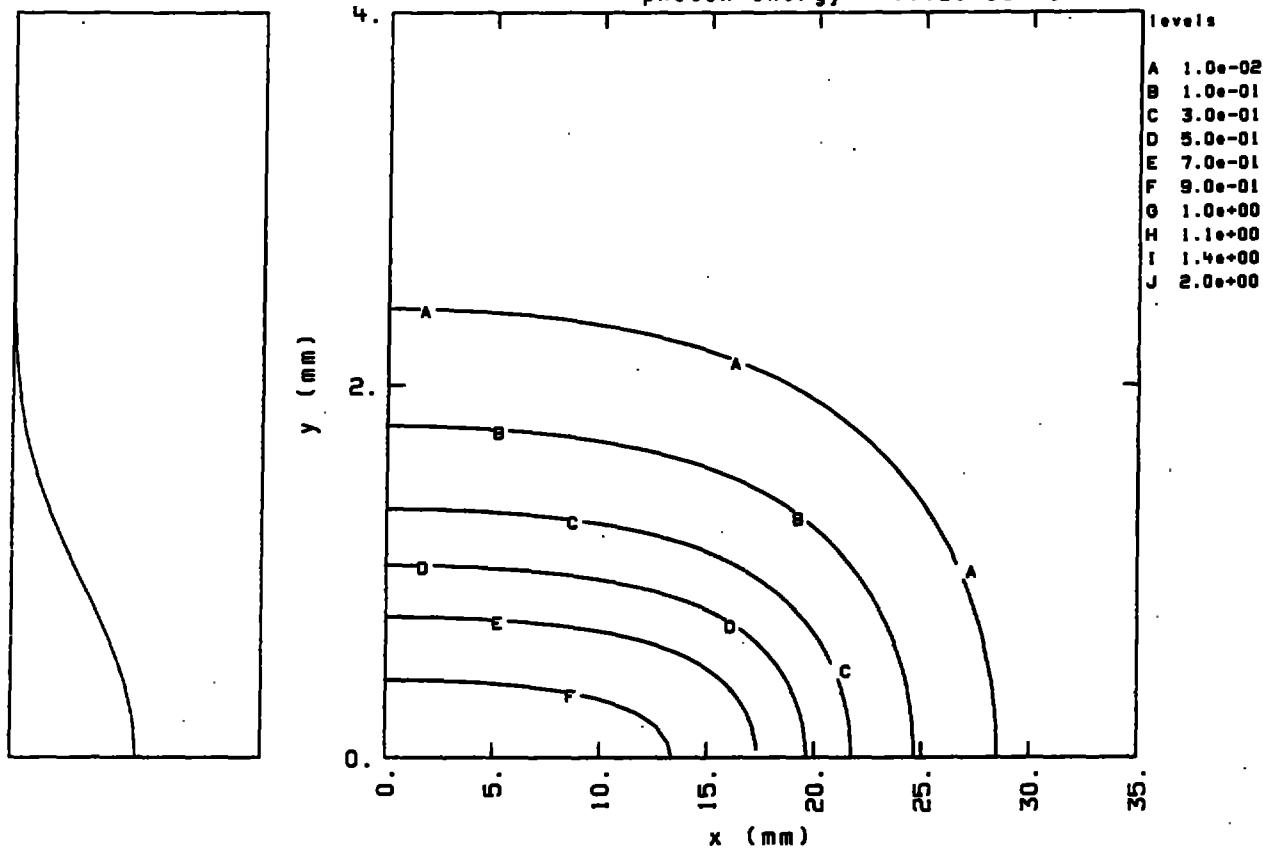


Fig. B5.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $7.78e+00$ keV



parallel
polarization

normalized to
 $z = 6.91e+10$
 at $x = 0.$
 $y = 0.$

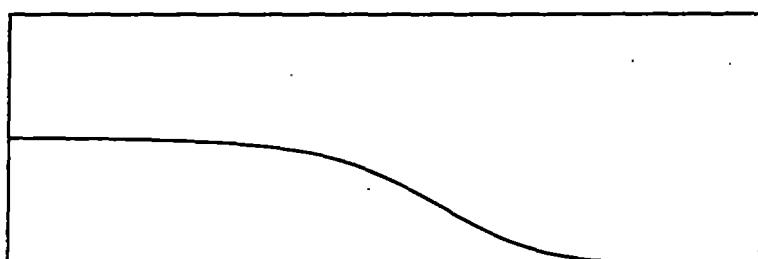


Fig. B5.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.00×10^0 GeV critical energy = 7.78×10^0 keV
 photon energy = 3.89×10^1 keV

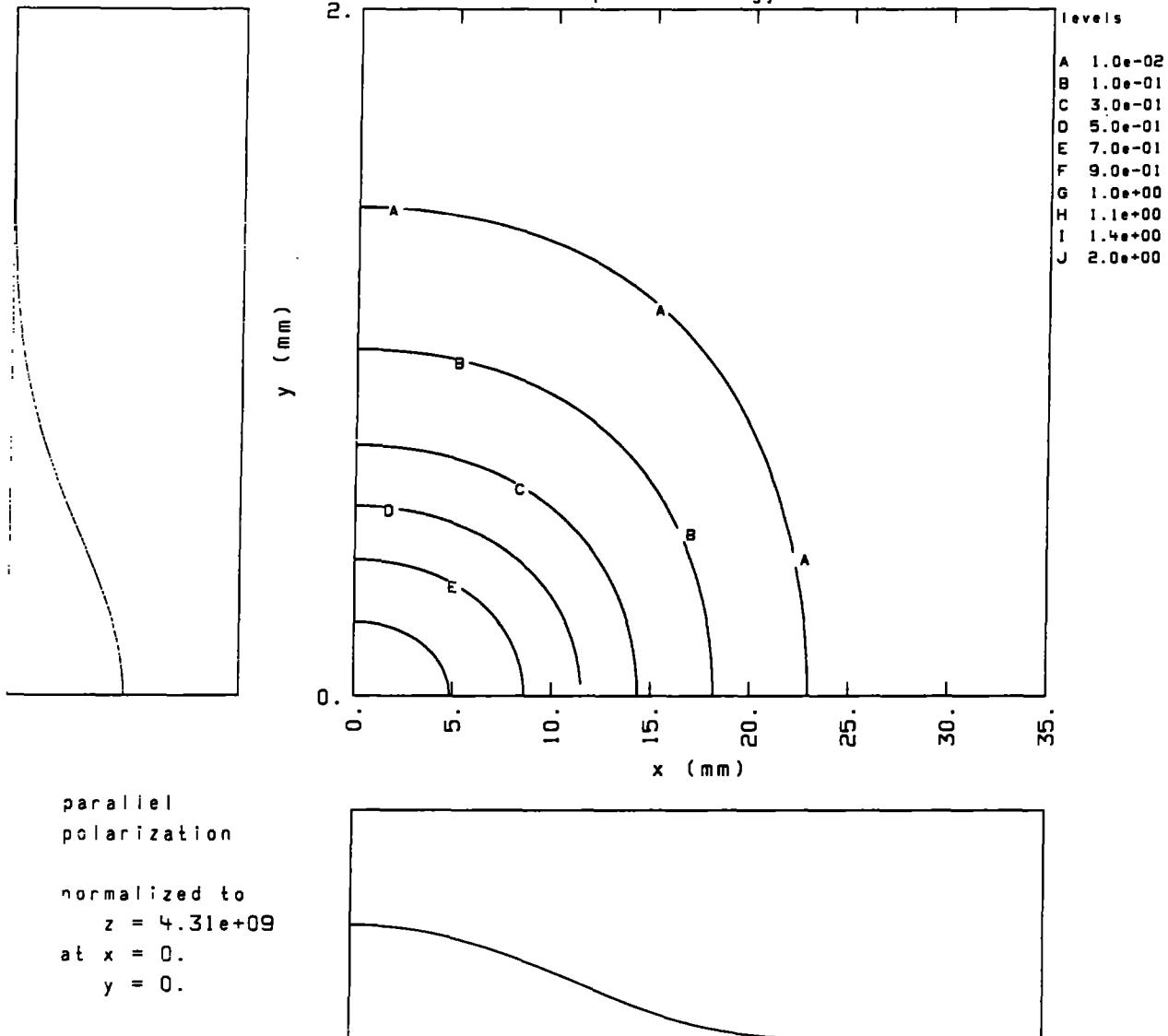
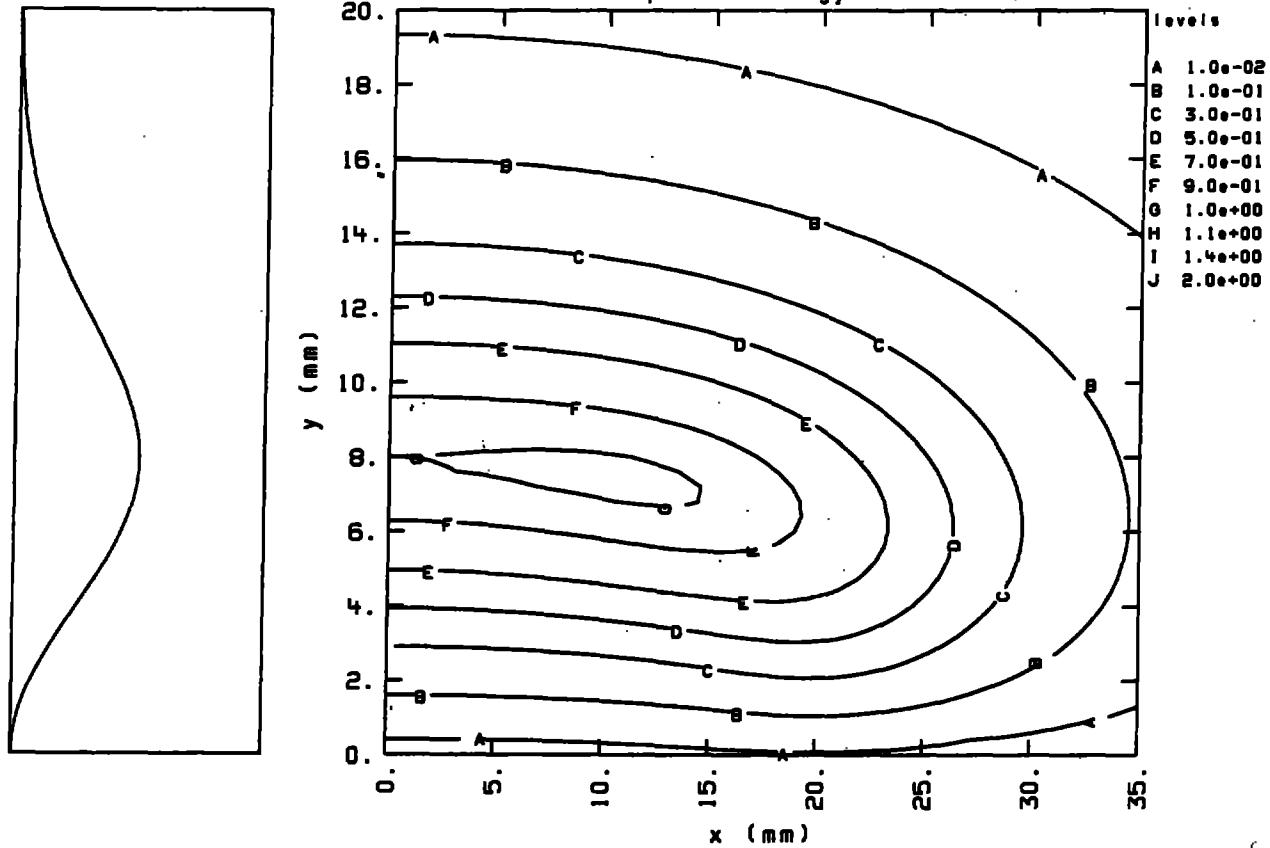


Fig. B5.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $2.00e-02$ keV



perpendicular
polarization

normalized to
 $z = 1.04e+09$
 at $x = 0$.
 $y = 8.00e+00$

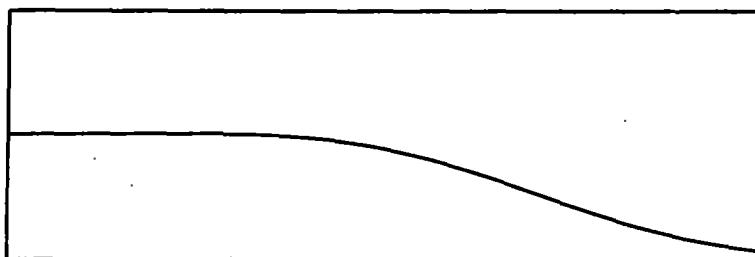
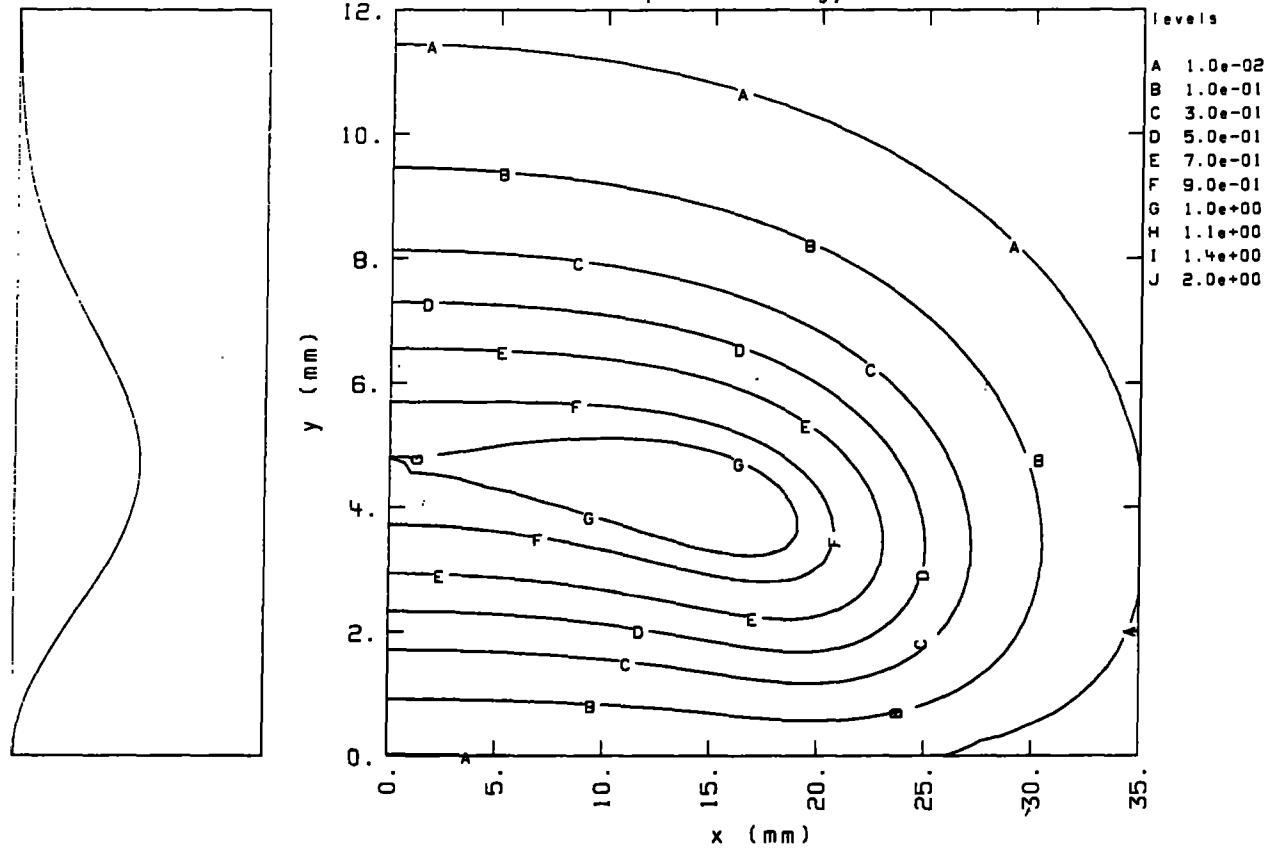


Fig. B6.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $1.00e-01$ keV



perpendicular
polarization

normalized to
 $z = 2.88e+09$
 at $x = 0$.
 $y = 4.80e+00$

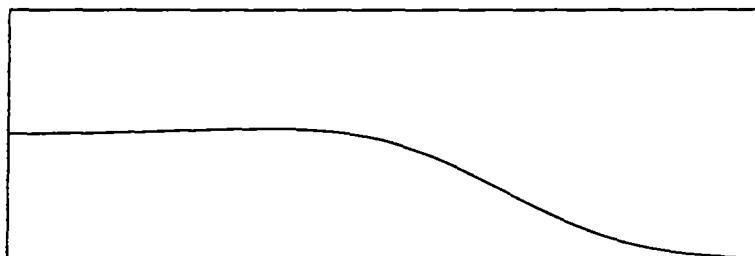
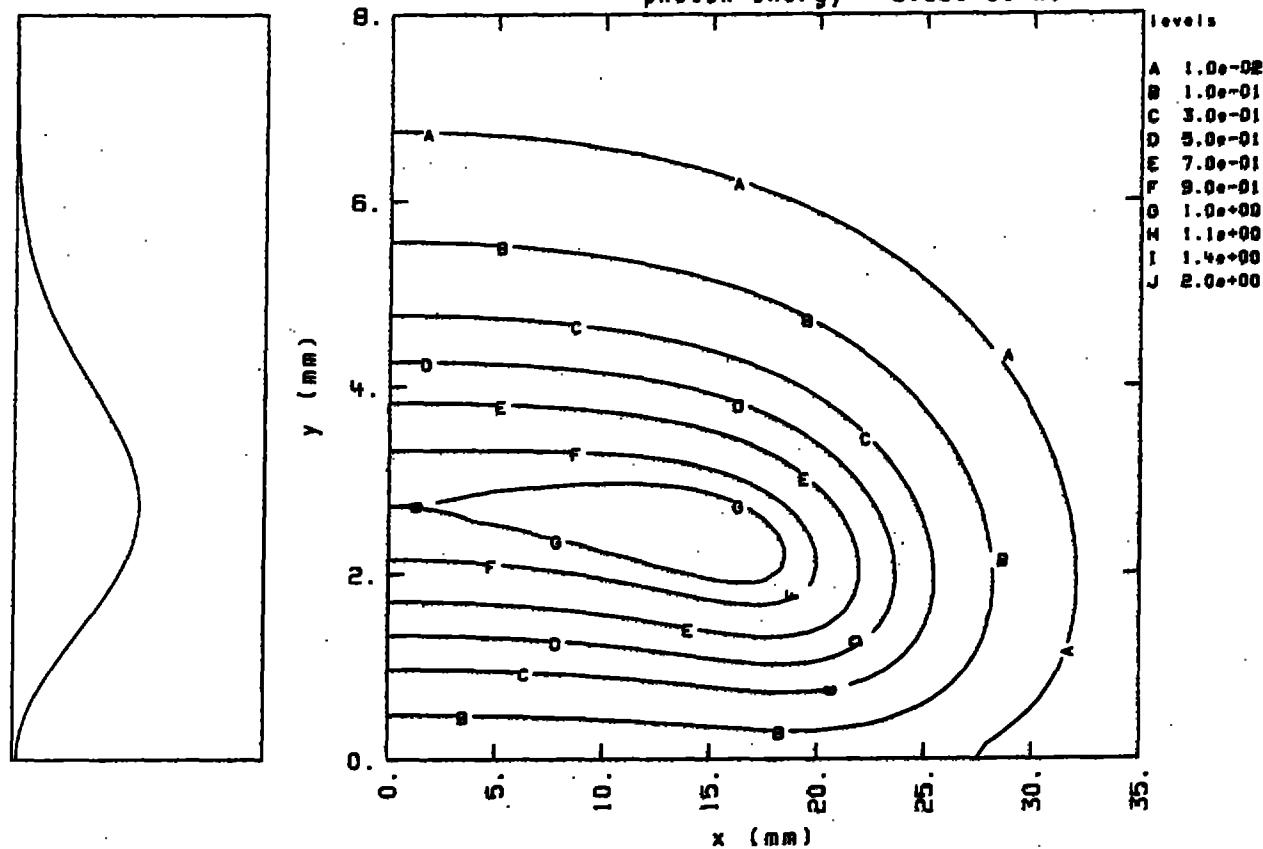


Fig. B6.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $5.00e-01$ keV



perpendicular
polarization

normalized to
 $z = 6.96e+09$
 at $x = 0$,
 $y = 2.72e+00$

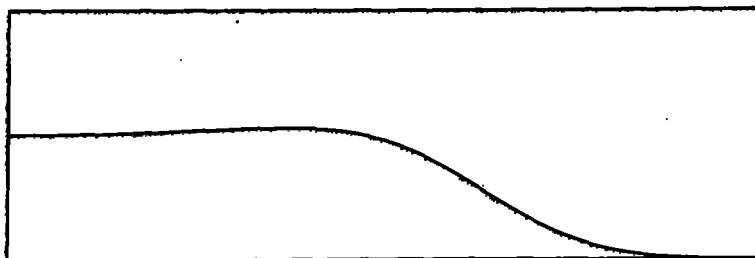


Fig. 86.3.

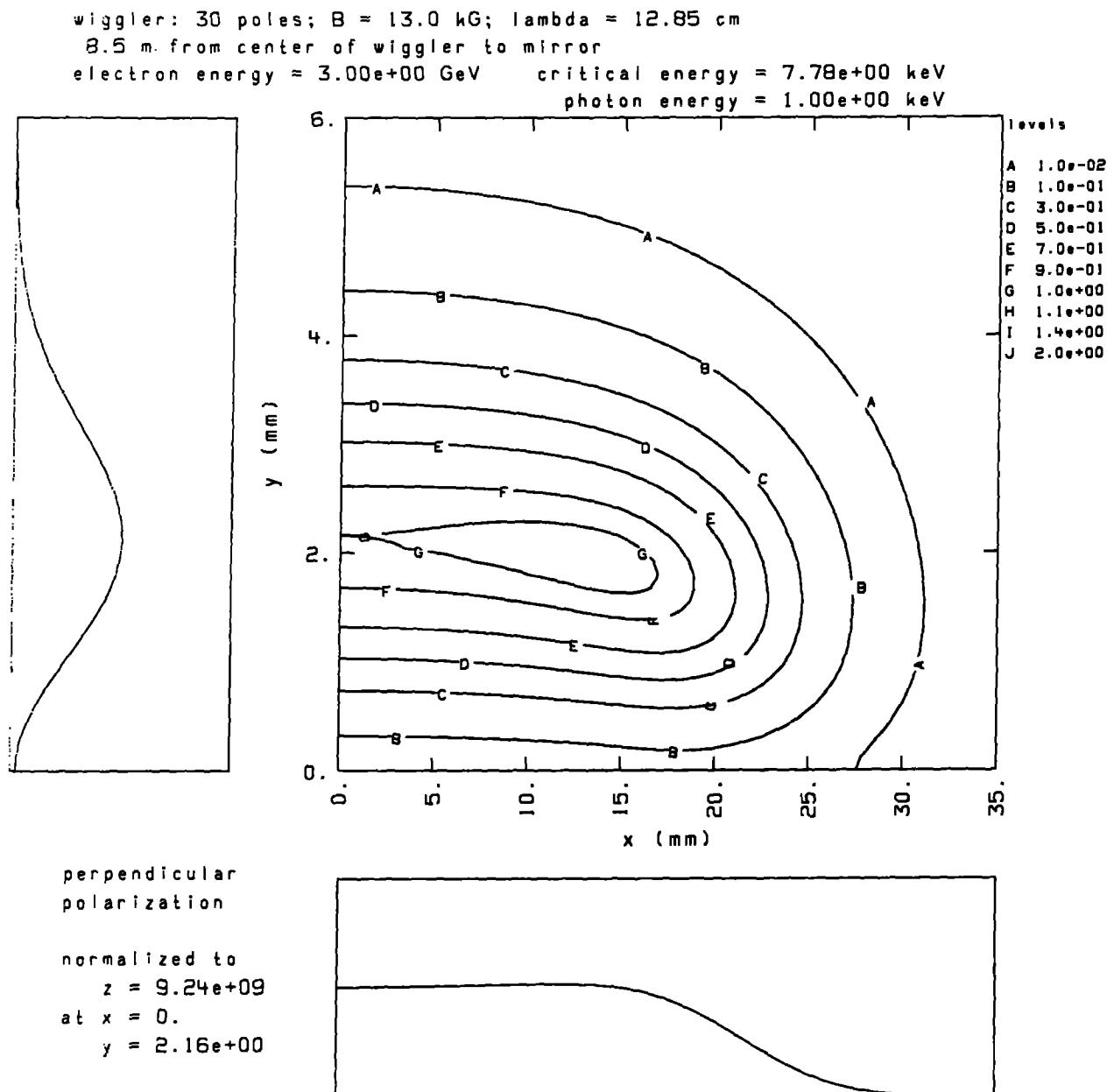


Fig. B6.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $3.89e+00$ keV

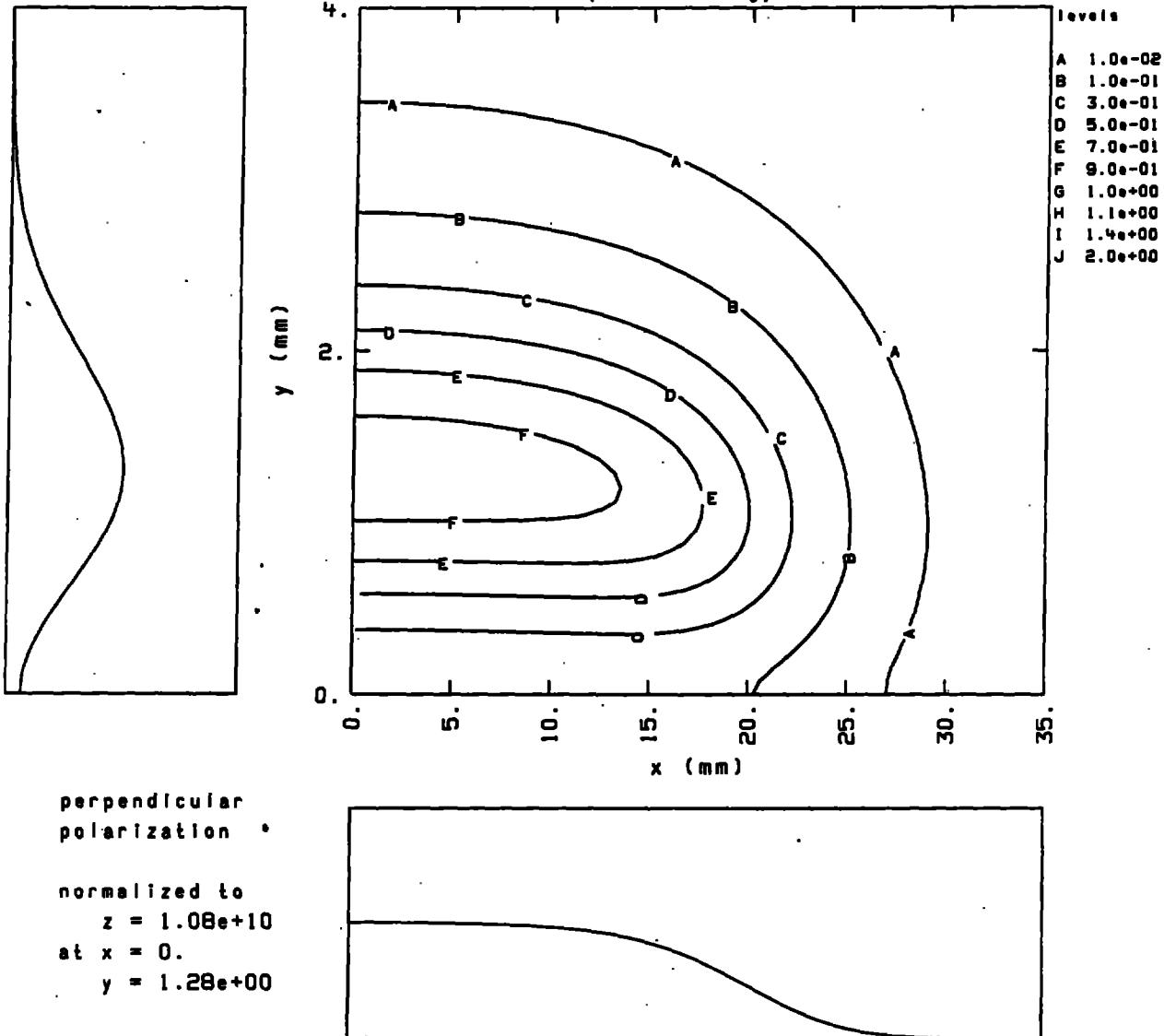
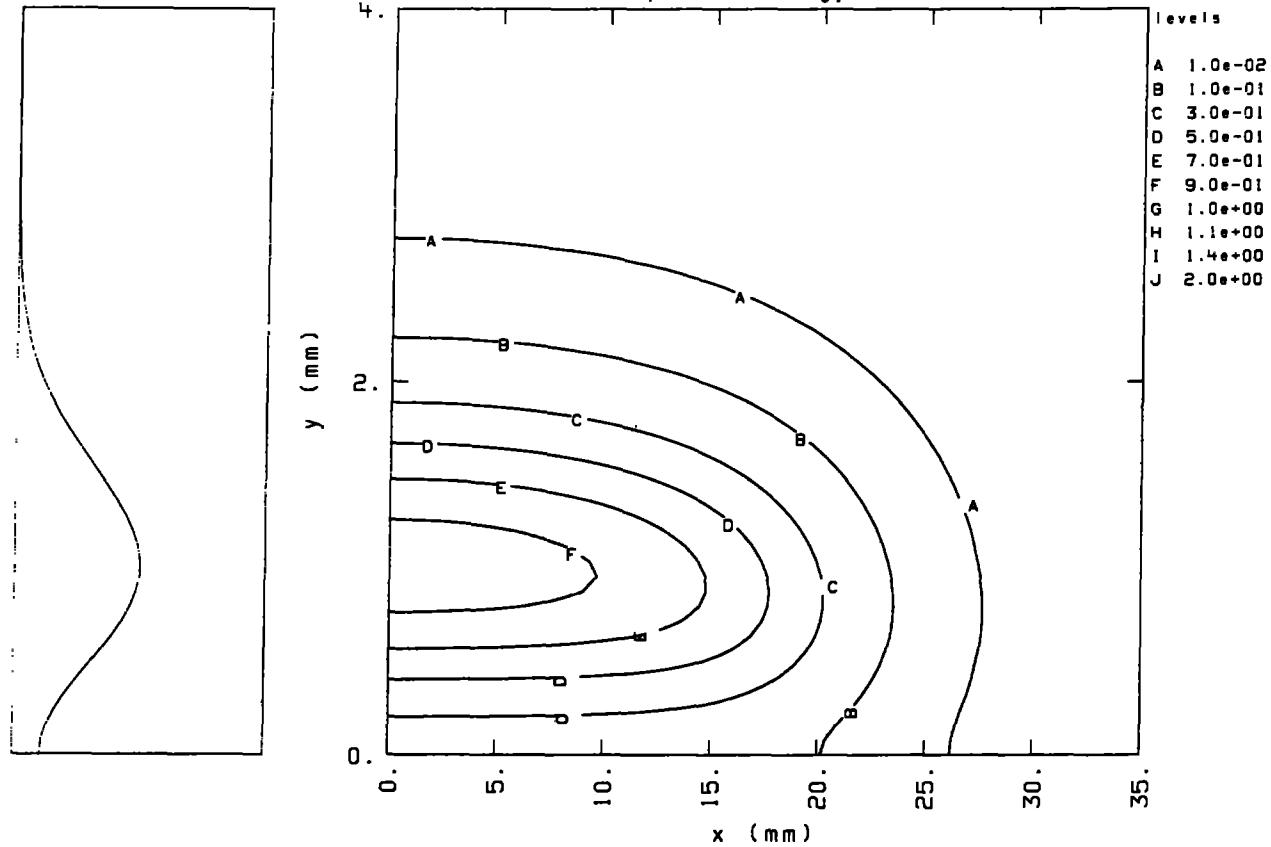


Fig. B6.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.00×10^0 GeV critical energy = 7.78×10^0 keV
 photon energy = 7.78×10^0 keV



perpendicular
polarization

normalized to
 $z = 7.63 \times 10^9$
 at $x = 0$.
 $y = 1.04 \times 10^0$

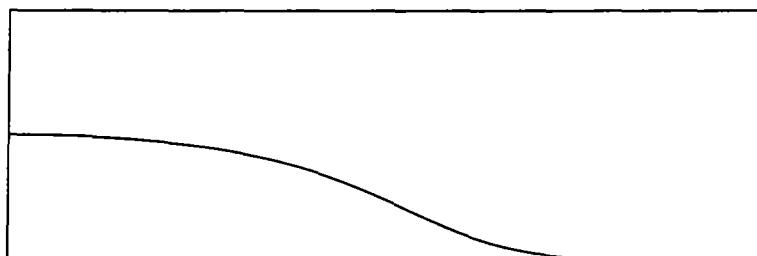
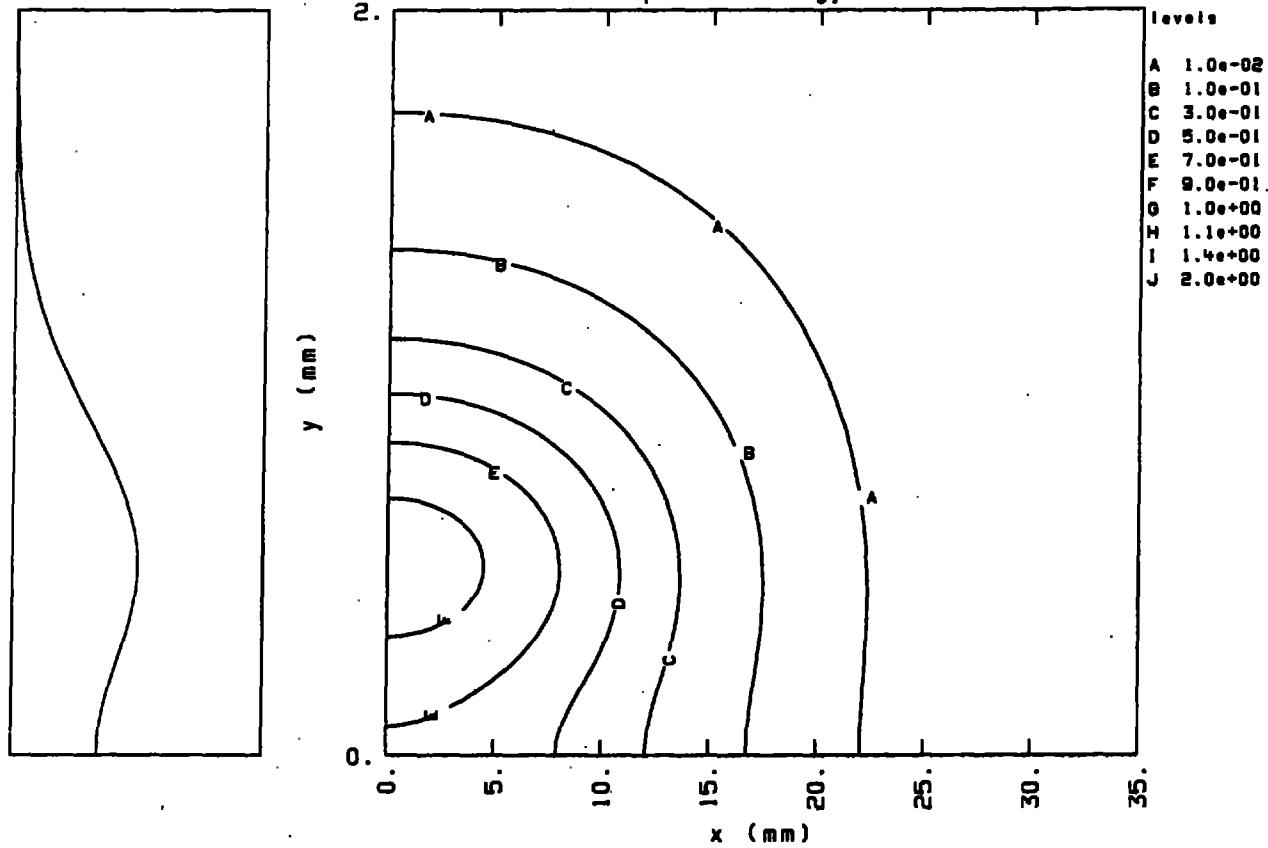


Fig. B6.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.00×10^0 GeV critical energy = 7.78×10^0 keV
 photon energy = 3.89×10^1 keV



perpendicular
polarization

normalized to
 $z = 1.37 \times 10^8$
 at $x = 0$.
 $y = 5.20 \times 10^{-1}$

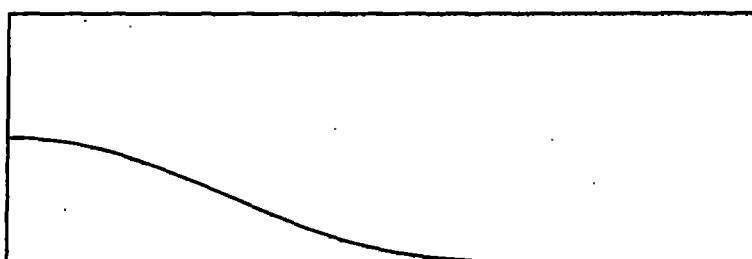
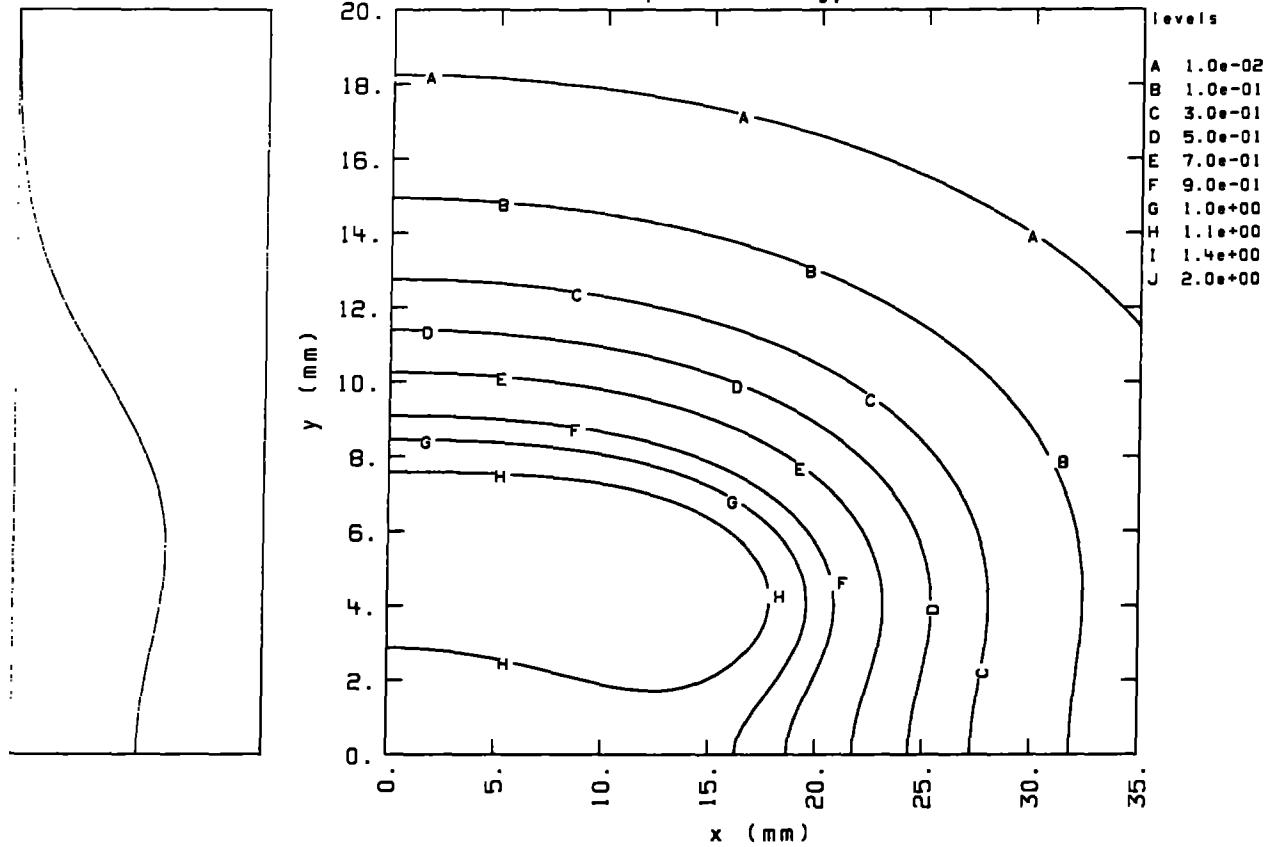


Fig. 86.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 3.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 2.00×10^{-2} keV



normalized to
 $z = 2.96 \times 10^9$
 at $x = 0$,
 $y = 0$.

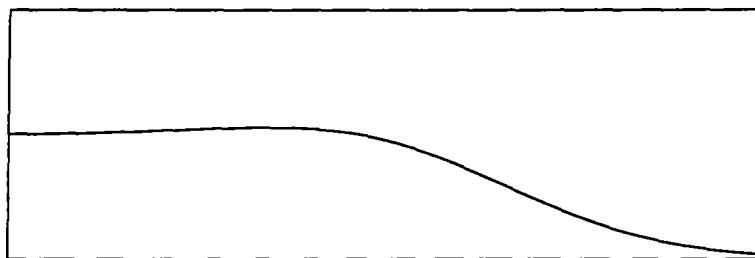
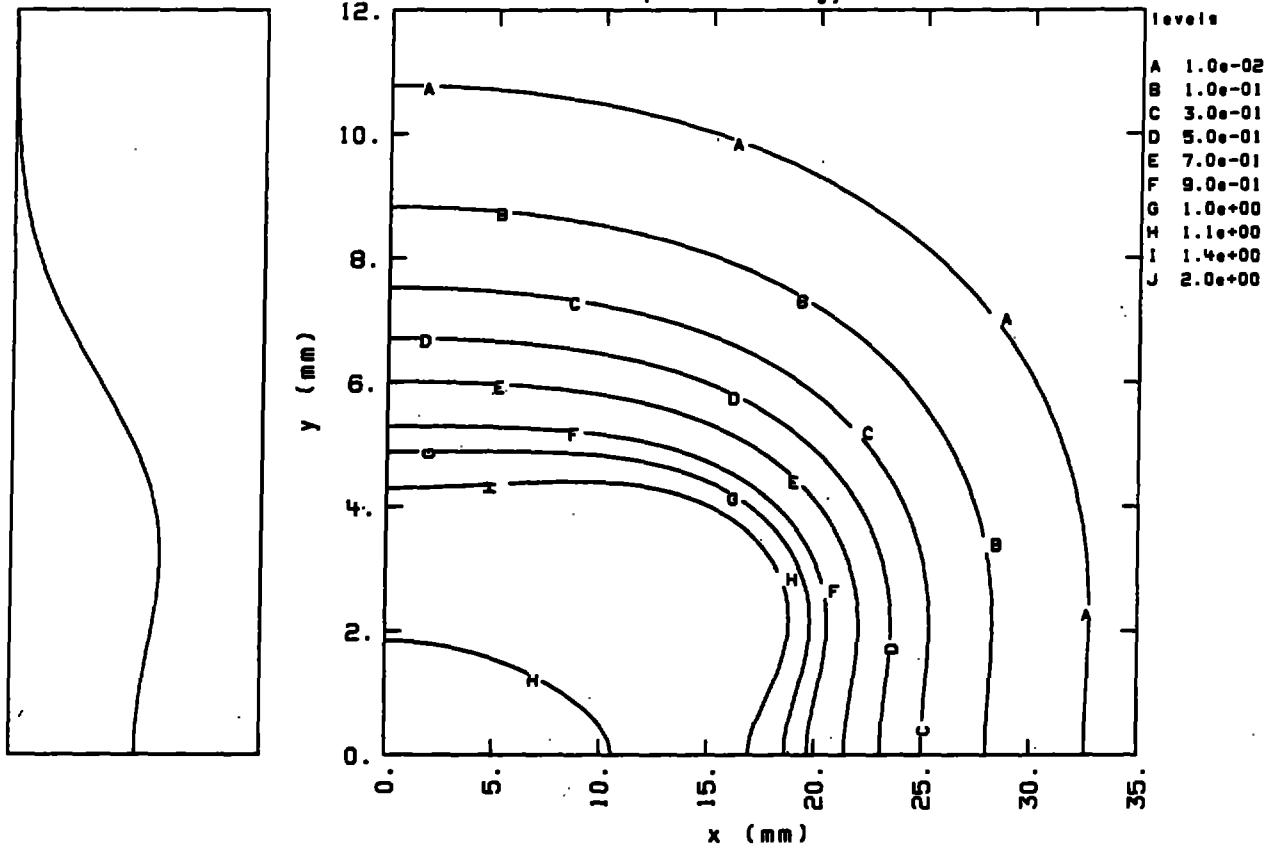


Fig. B7.1

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 1.00×10^{-1} keV



normalized to
 $z = 8.78 \times 10^9$
 at $x = 0$.
 $y = 0$.

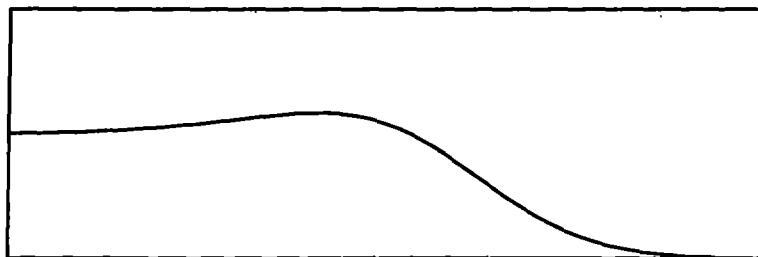
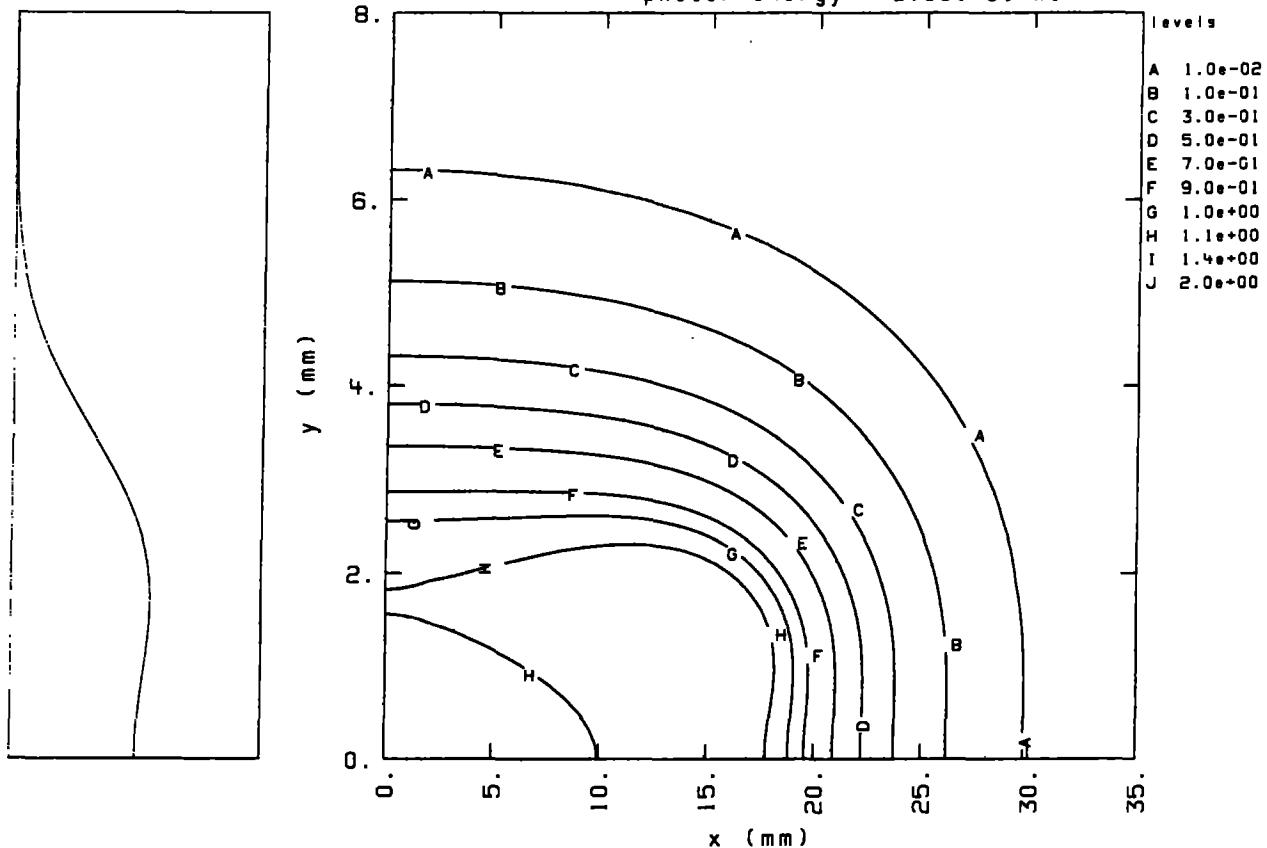


Fig. B7.2

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.00e-01$ keV



normalized to
 $z = 2.54e+10$
 at $x = 0.$
 $y = 0.$

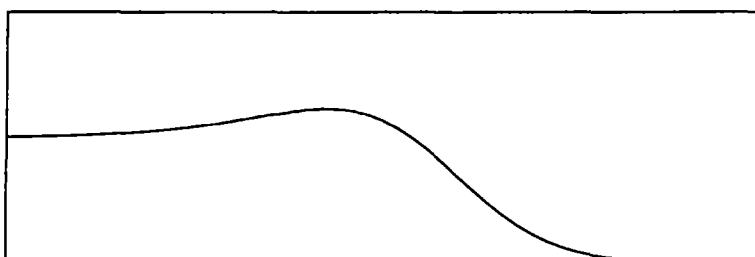
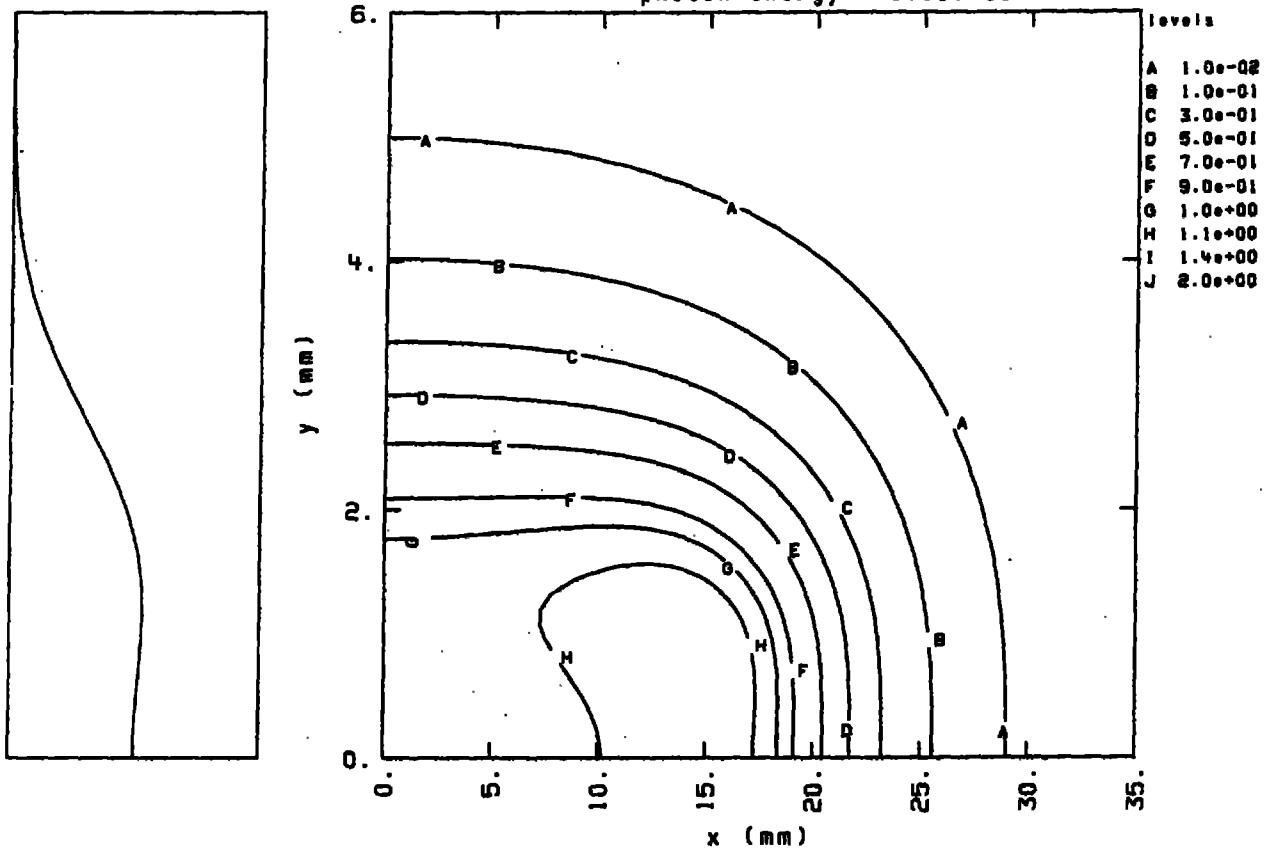


Fig. B7.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e+00$ keV



normalized to
 $z = 3.95e+10$
 at $x = 0.$
 $y = 0.$

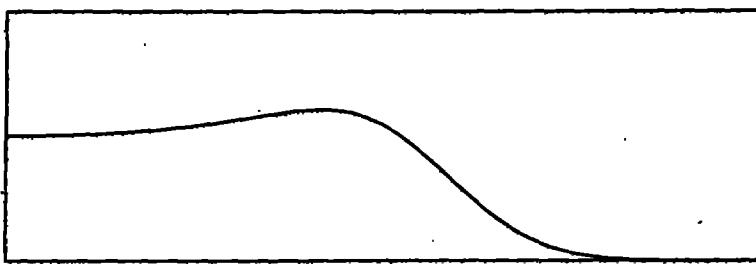


Fig. B7.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 5.01×10^0 keV

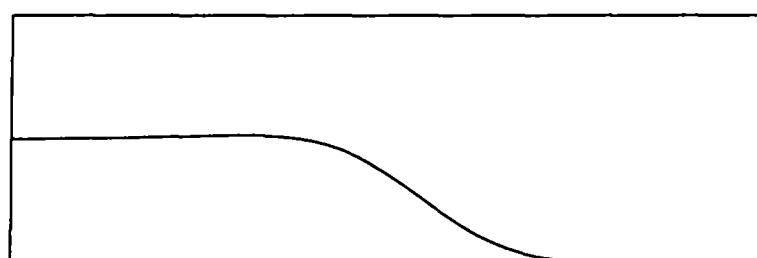
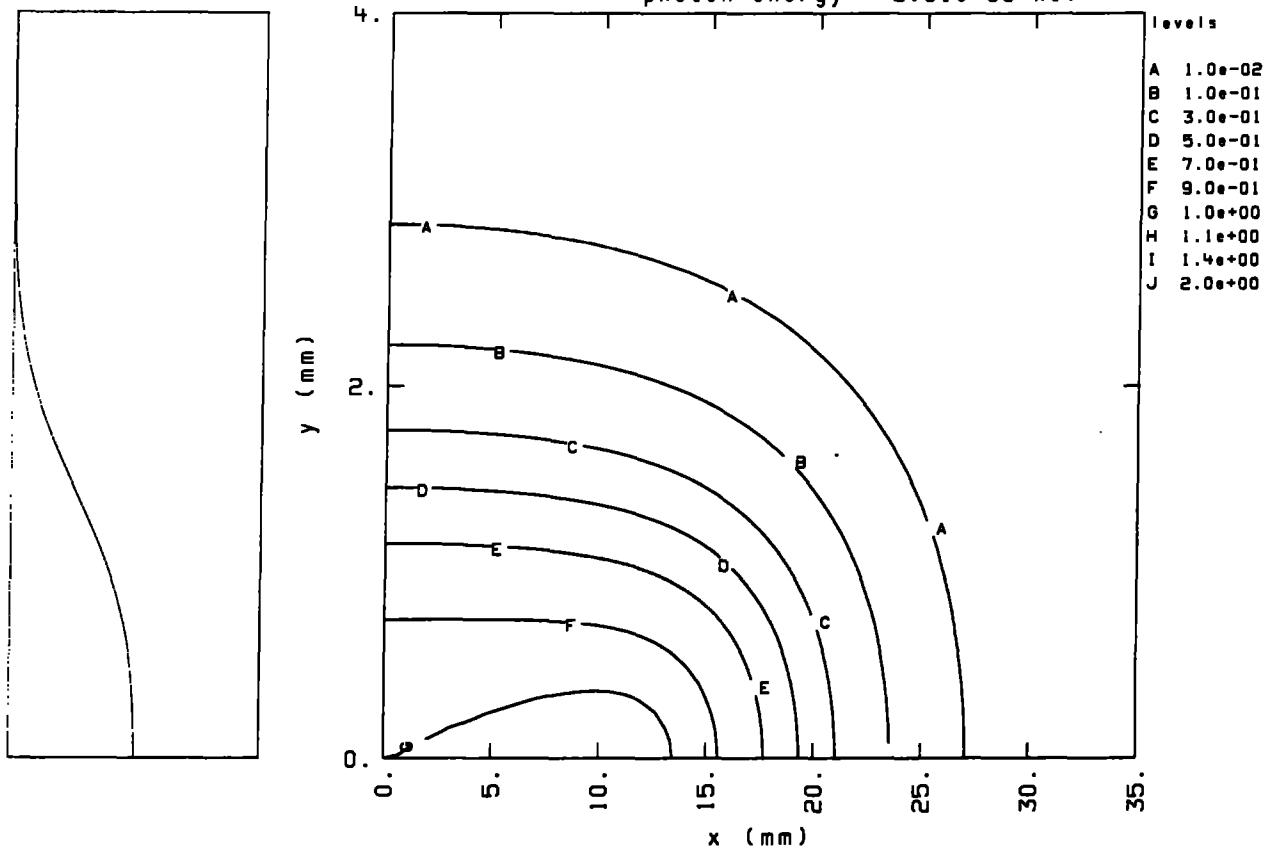
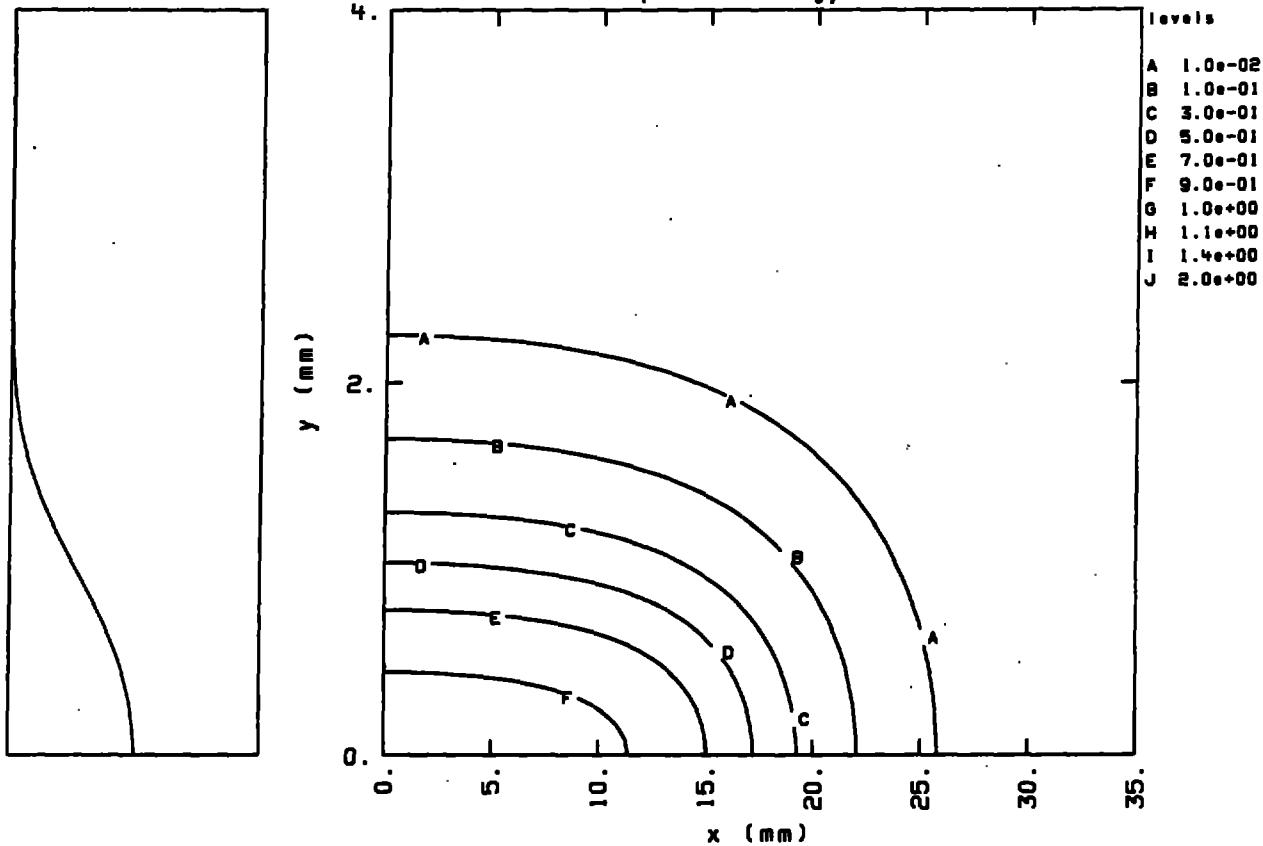


Fig. B7.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $1.00e+01$ keV



normalized to
 $z = 9.03e+10$
at $x = 0.$
 $y = 0.$

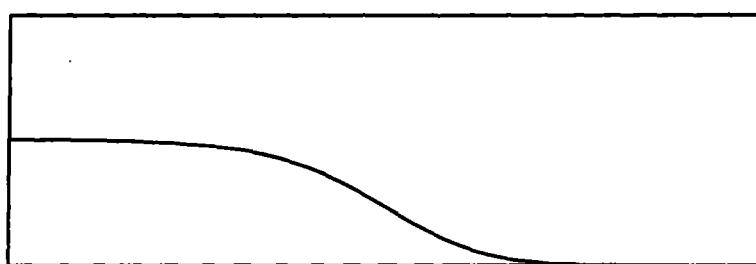
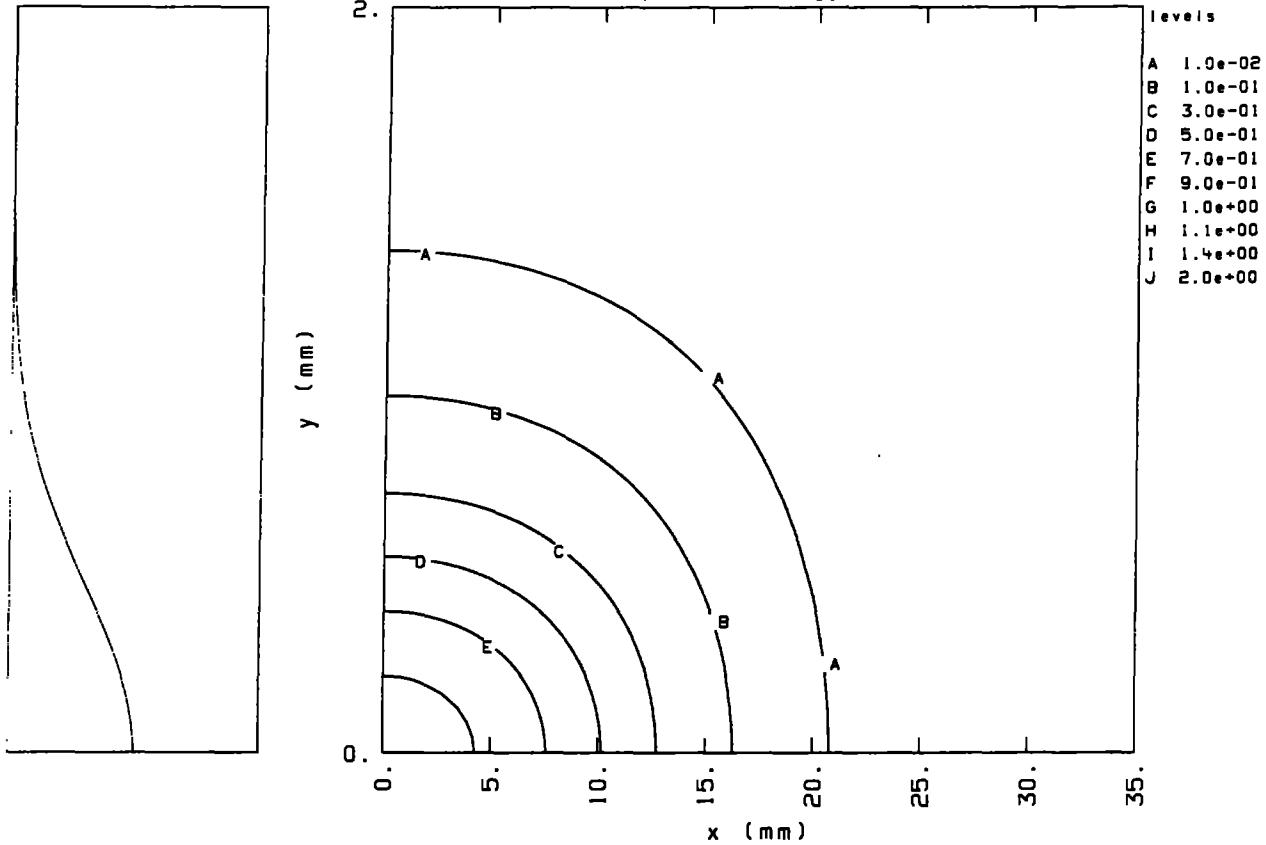


Fig. B7.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.01e+01$ keV



normalized to
 $z = 5.34e+09$
 at $x = 0.$
 $y = 0.$

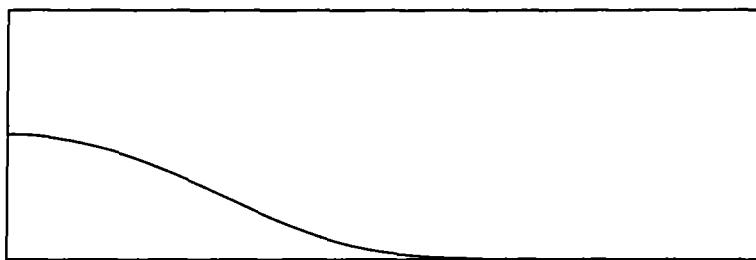
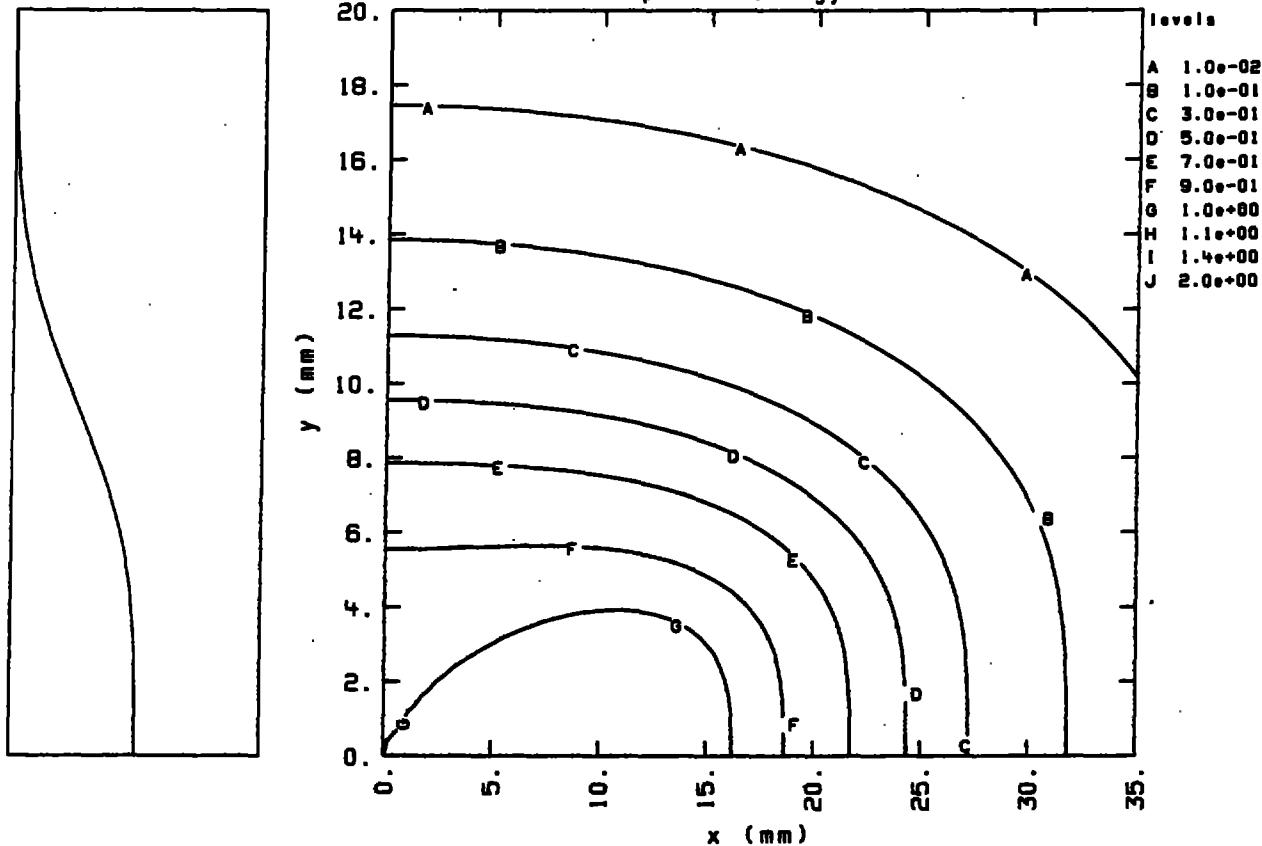


Fig. B7.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $2.00e-02$ keV



parallel
polarization

normalized to
 $z = 2.95e+09$
 at $x = 0$,
 $y = 0$.

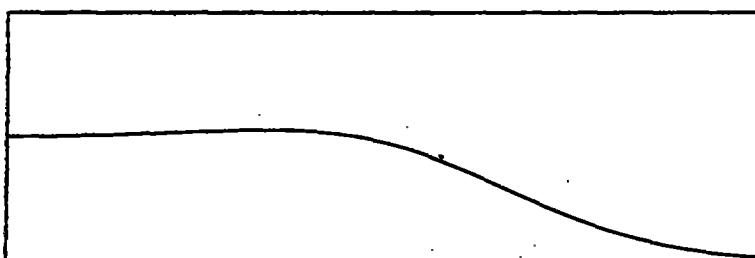
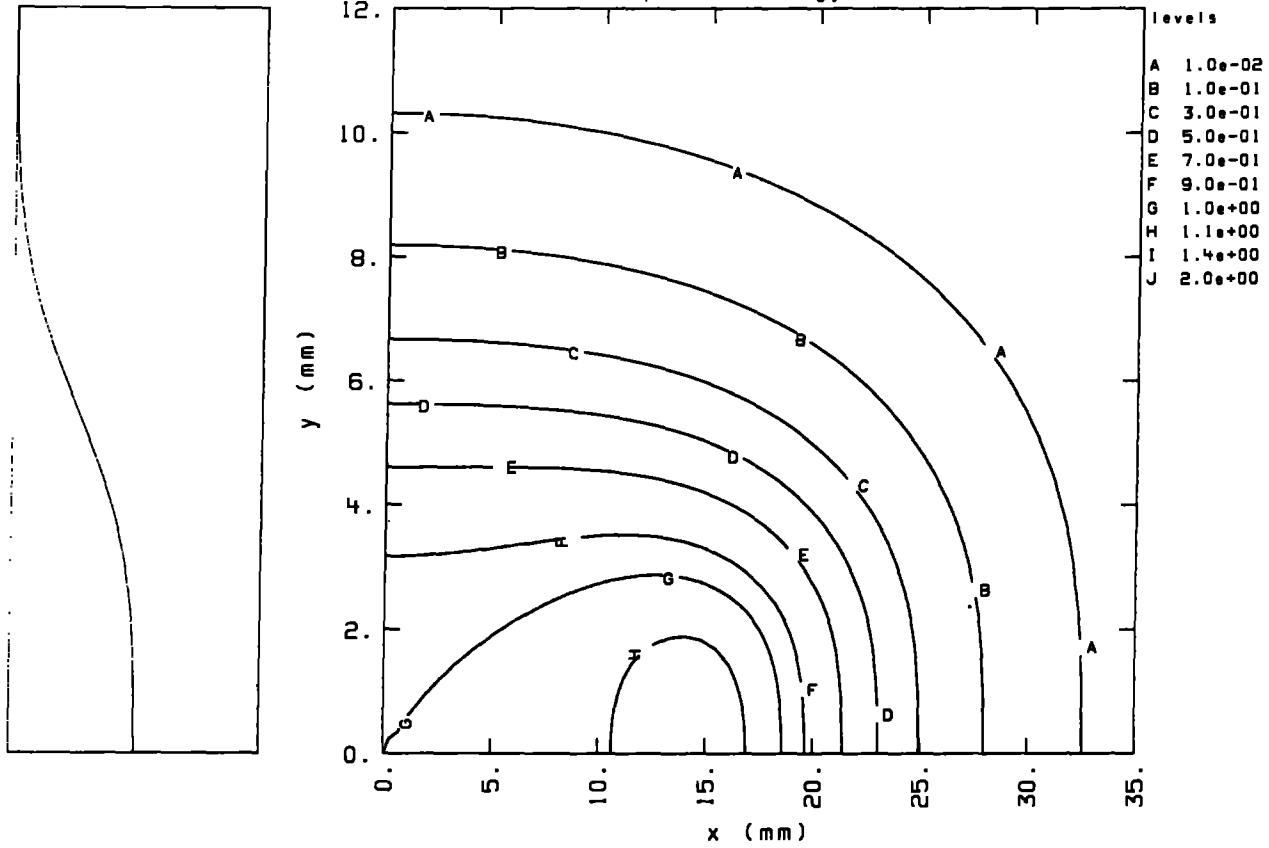


Fig. B8.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e-01$ keV



parallel
polarization

normalized to
 $z = 8.75e+09$
 at $x = 0.$
 $y = 0.$

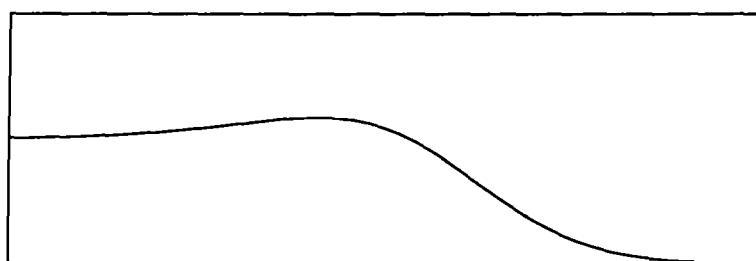
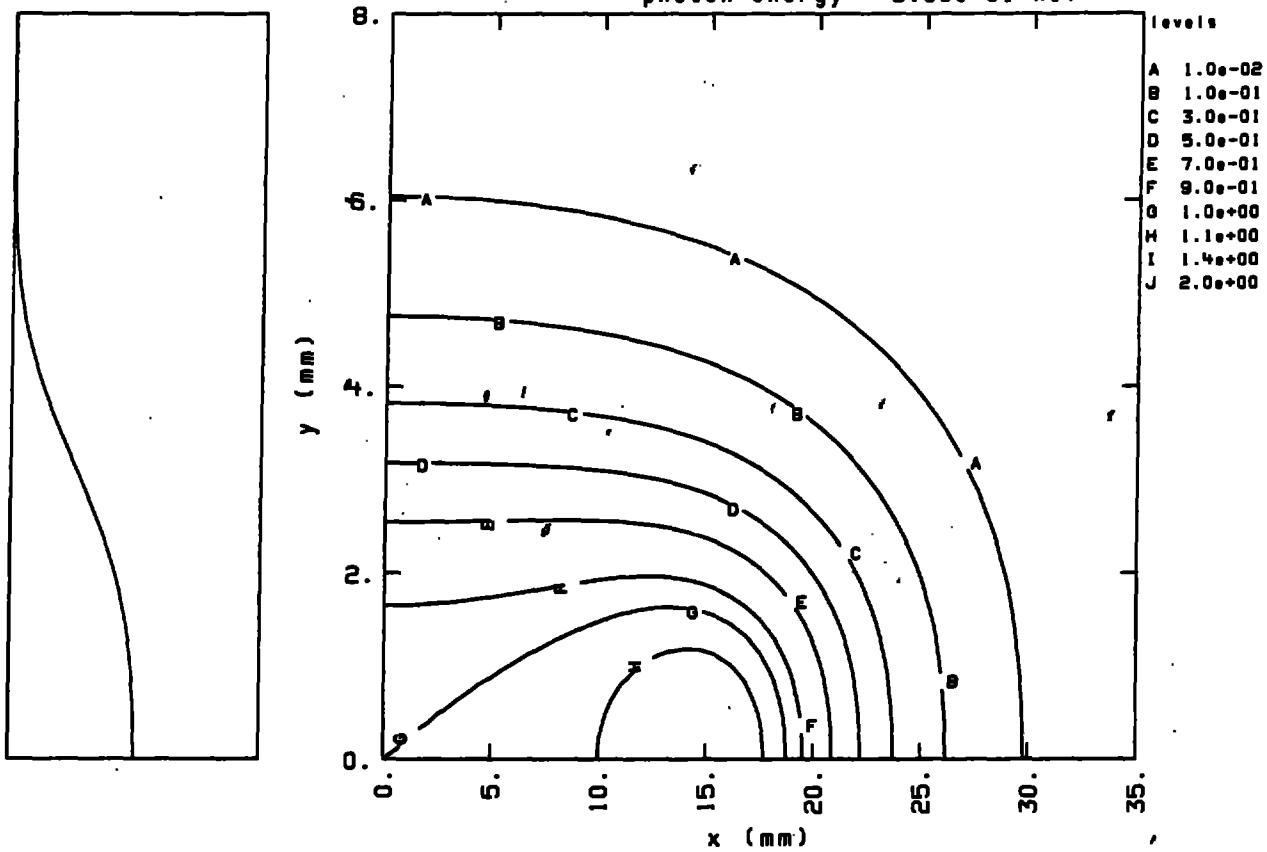


Fig. B8.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.00e-01$ keV



parallel
polarization

normalized to
 $z = 2.52e+10$
 at $x = 0$.
 $y = 0$.

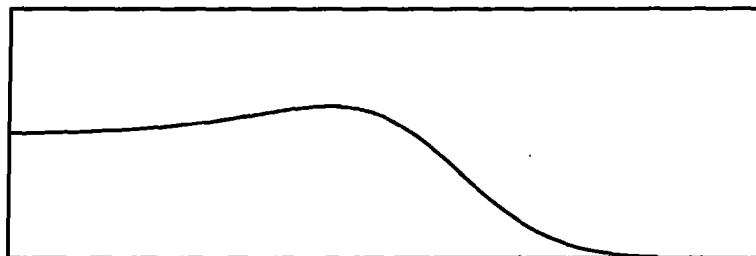
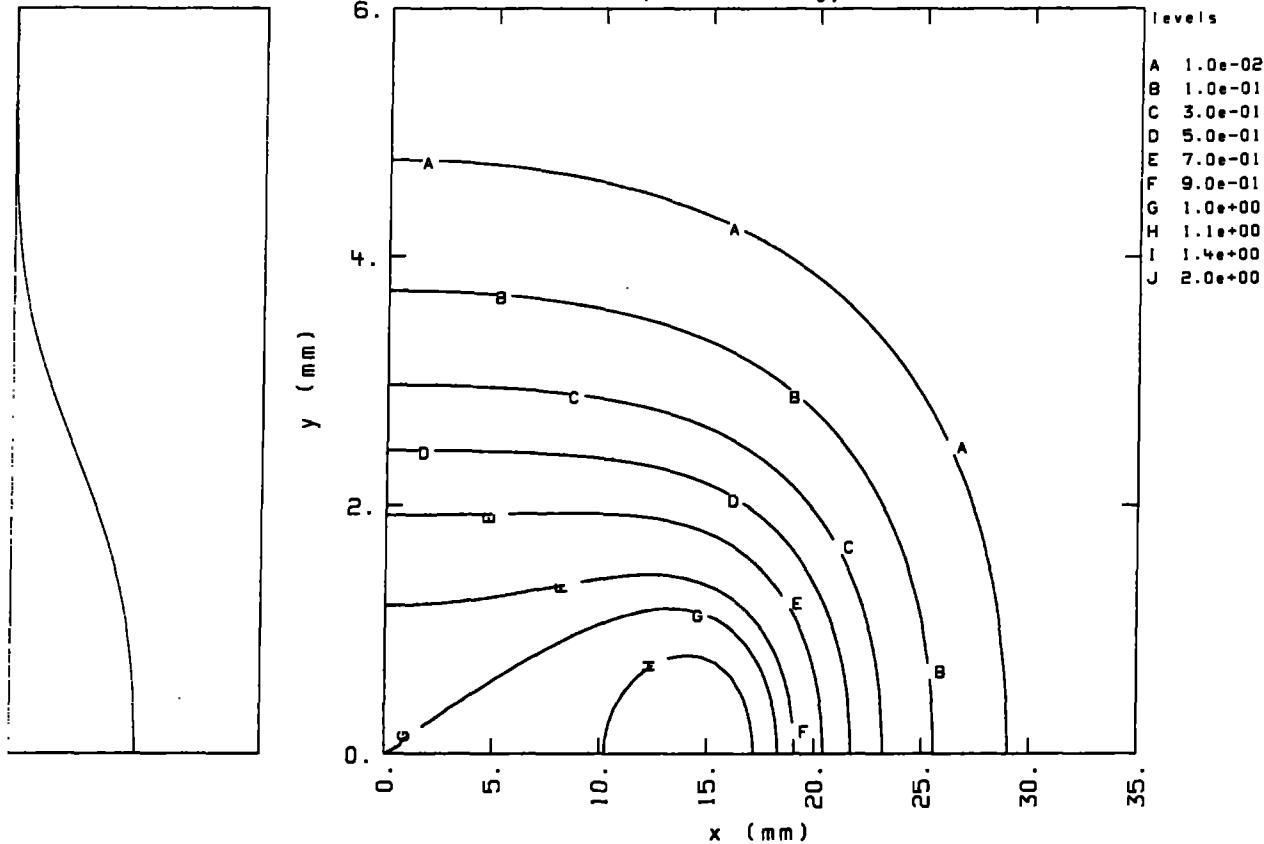


Fig. B8.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e+00$ keV



parallel
polarization

 normalized to
 $z = 3.90e+10$
 at $x = 0.$
 $y = 0.$

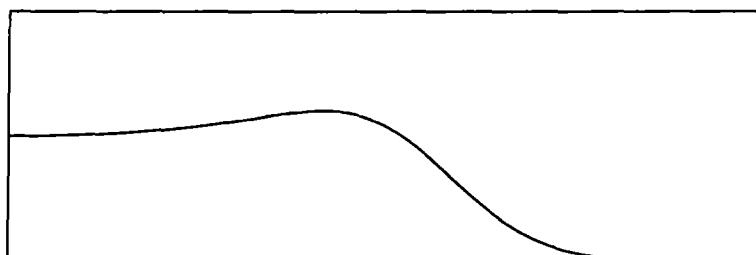


Fig. 88.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.01e+00$ keV

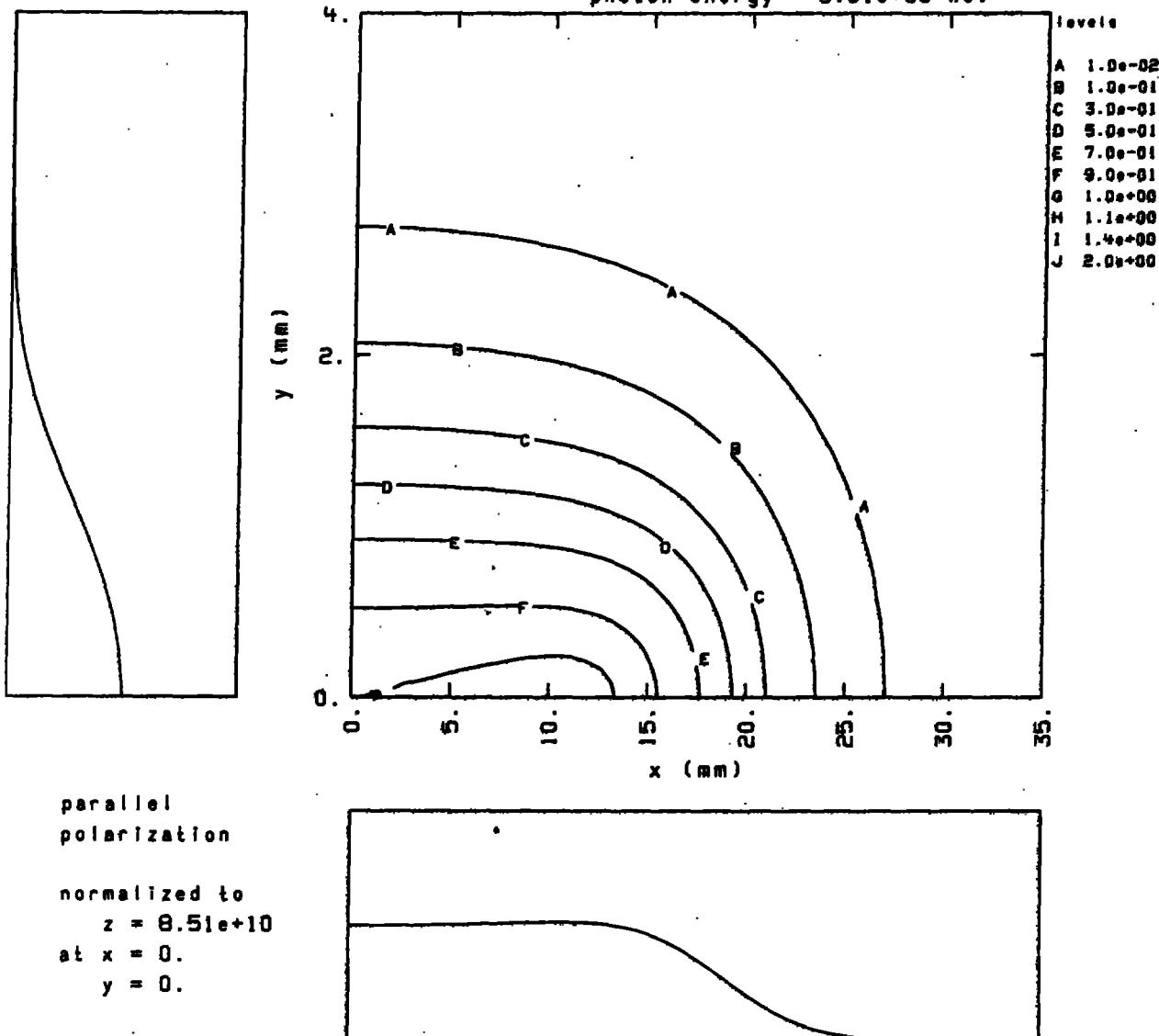
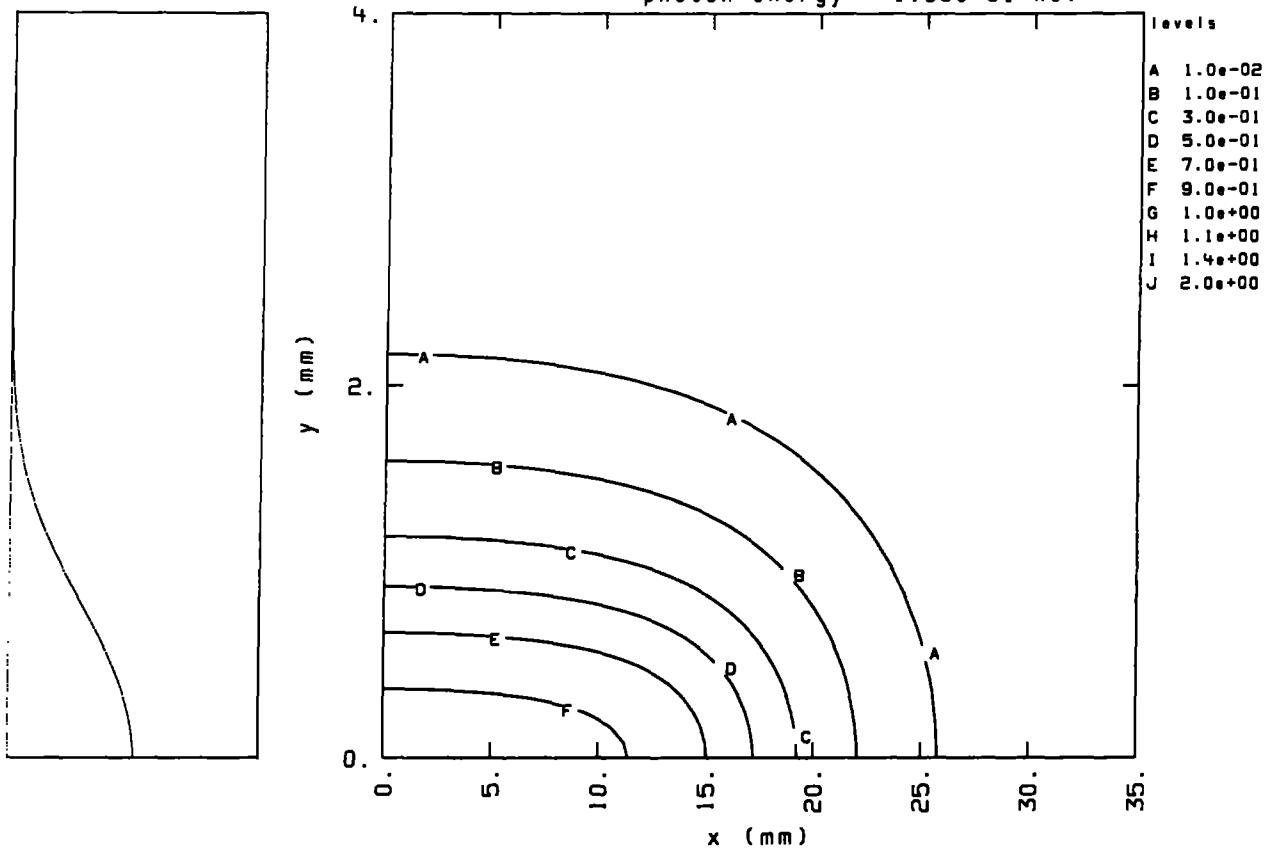


Fig. B8.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 1.00×10^1 keV



parallel
polarization

 normalized to
 $z = 8.77 \times 10^{10}$
 at $x = 0.$
 $y = 0.$

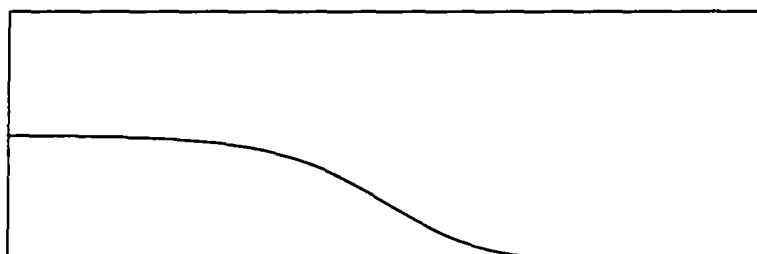


Fig. B8.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 0.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.01e+01$ keV

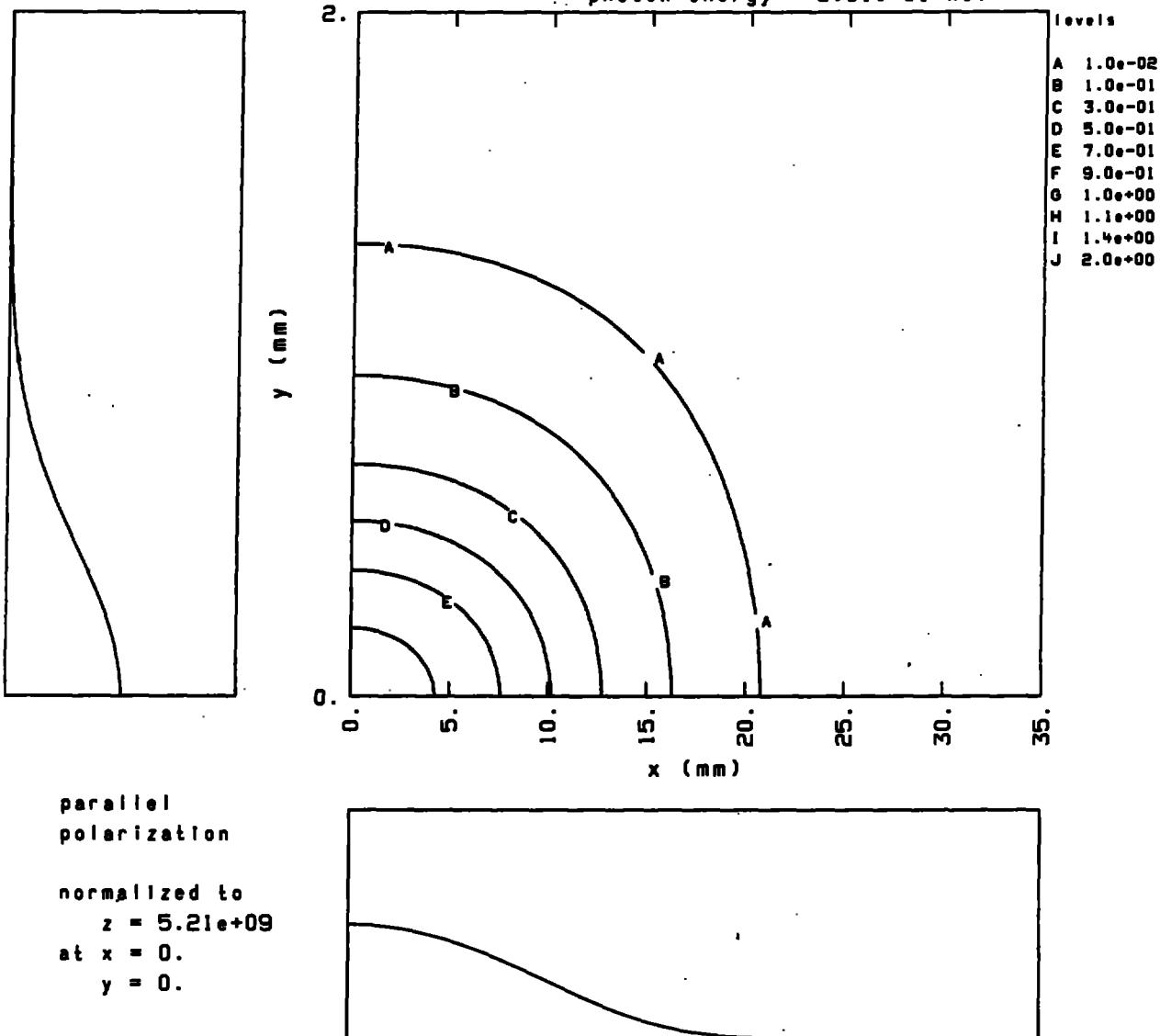
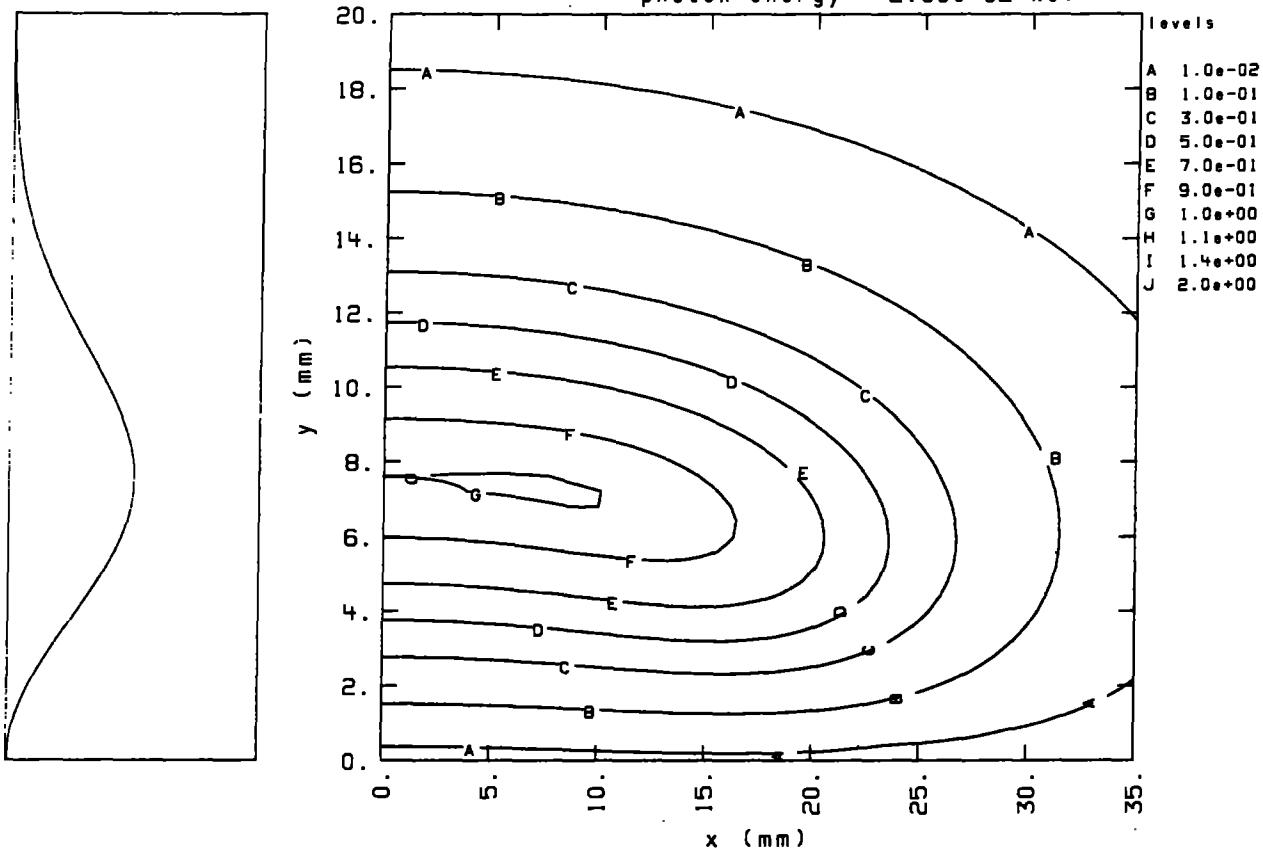


Fig. B8.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 2.00×10^{-2} keV



perpendicular
polarization

normalized to
 $z = 1.13 \times 10^9$
 at $x = 0$.
 $y = 7.60 \times 10^0$

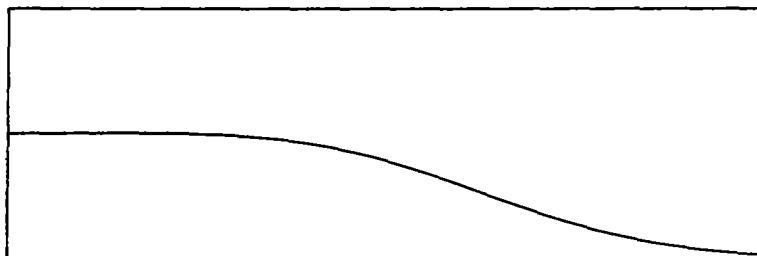
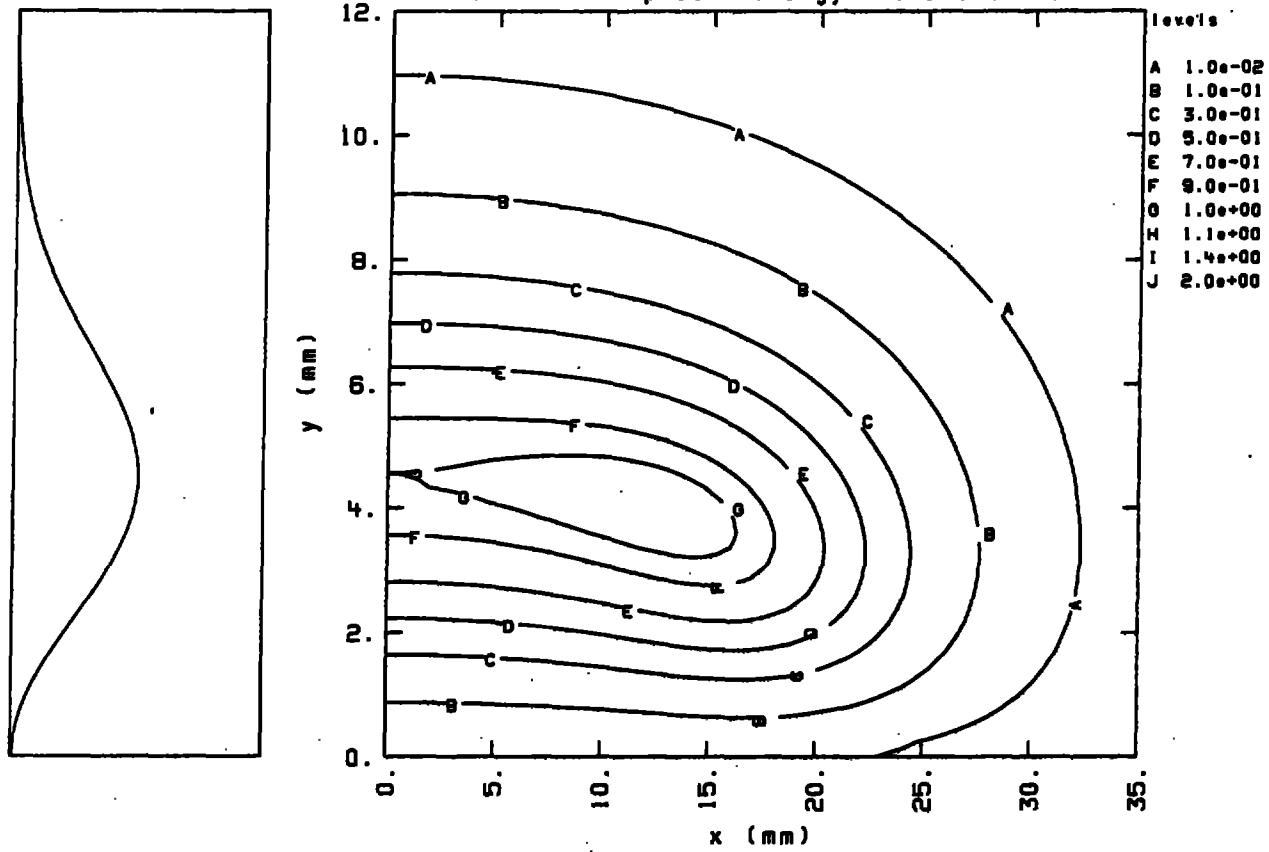


Fig. B9.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 0.5 m from center of wiggler to mirror
electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e-01$ keV



perpendicular
polarization

normalized to
 $z = 3.18e+09$
at $x = 0$.
 $y = 4.56e+00$

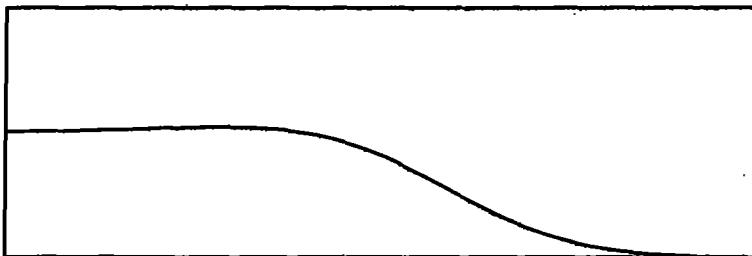
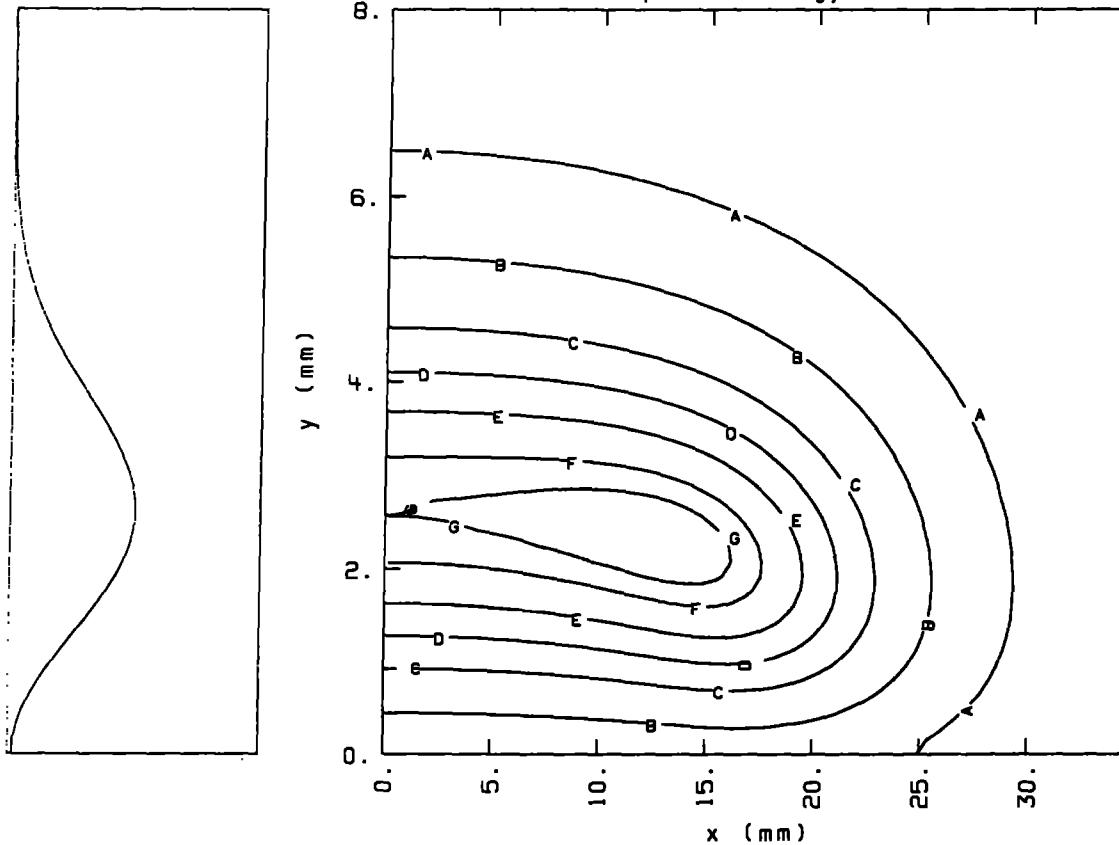


Fig. B9.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 5.00×10^{-1} keV



perpendicular
polarization

normalized to
 $z = 7.88 \times 10^9$
 at $x = 0$.
 $y = 2.56 \times 10^0$

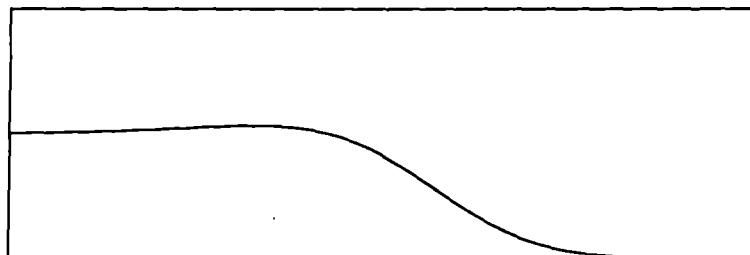
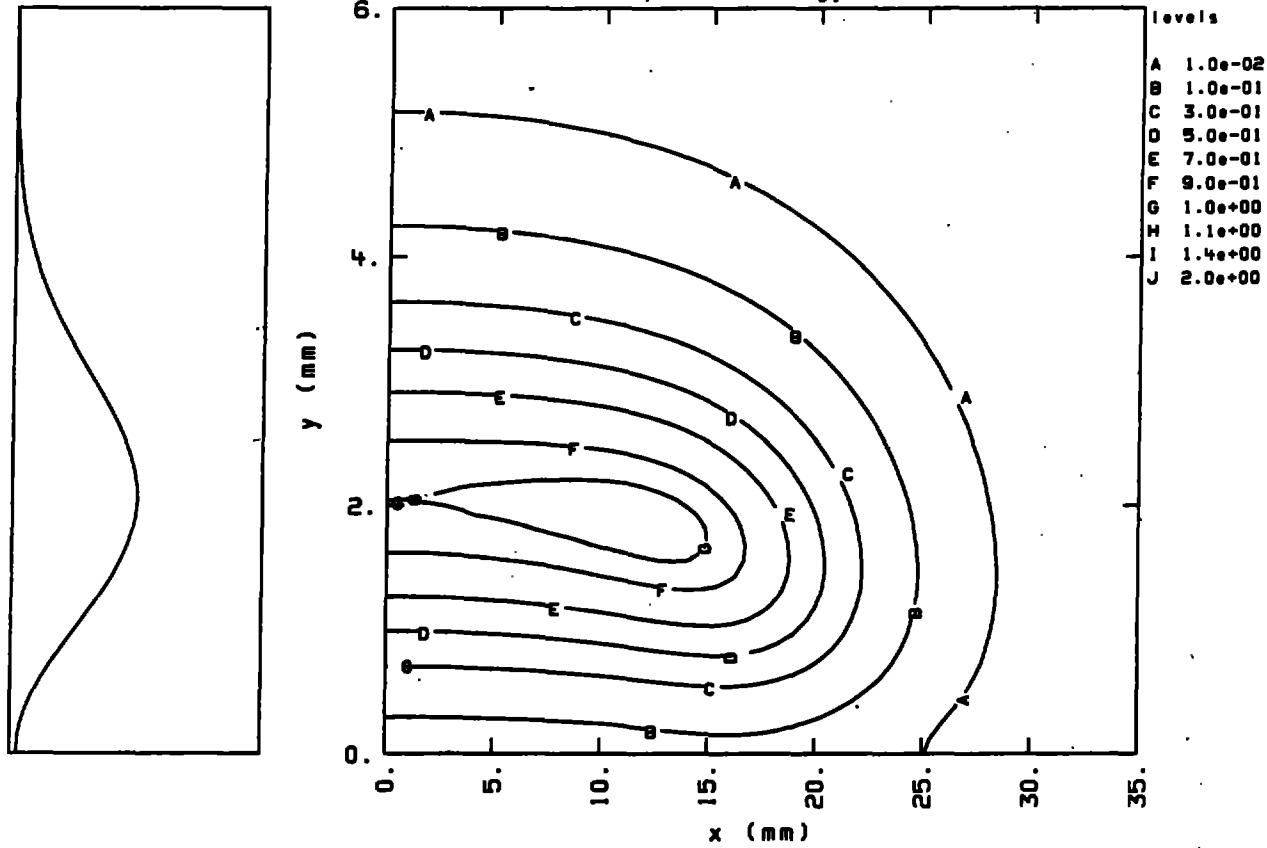


Fig. B9.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e+00$ keV



perpendicular
polarization

normalized to
 $z = 1.07e+10$
 at $x = 0$.
 $y = 2.04e+00$

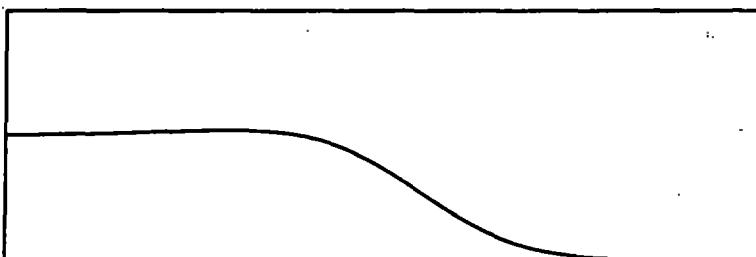
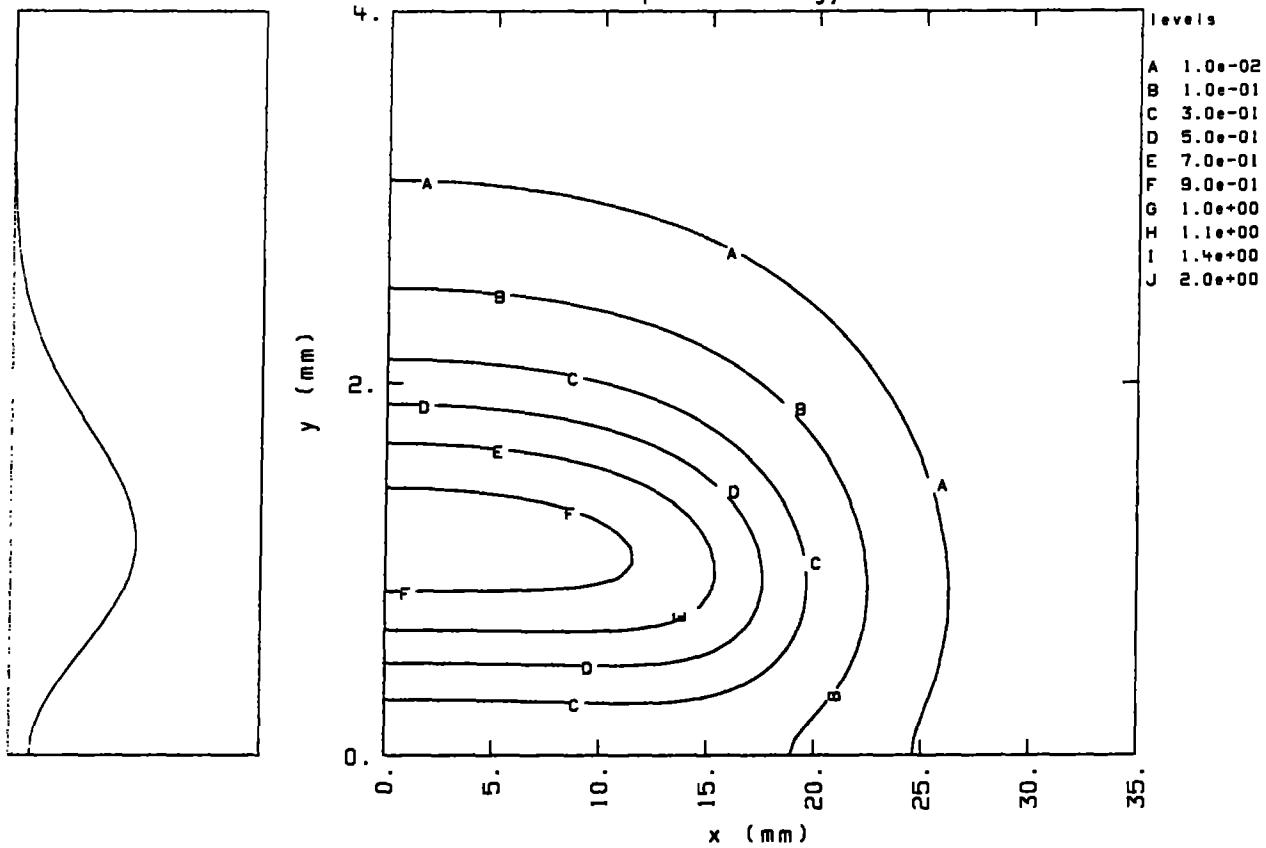


Fig. B9.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.01e+00$ keV



perpendicular
polarization

normalized to
 $z = 1.35e+10$
 at $x = 0$.
 $y = 1.12e+00$

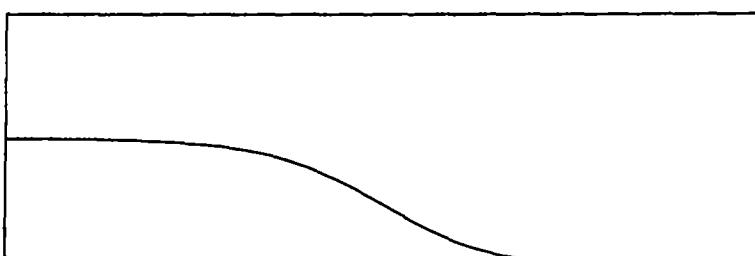
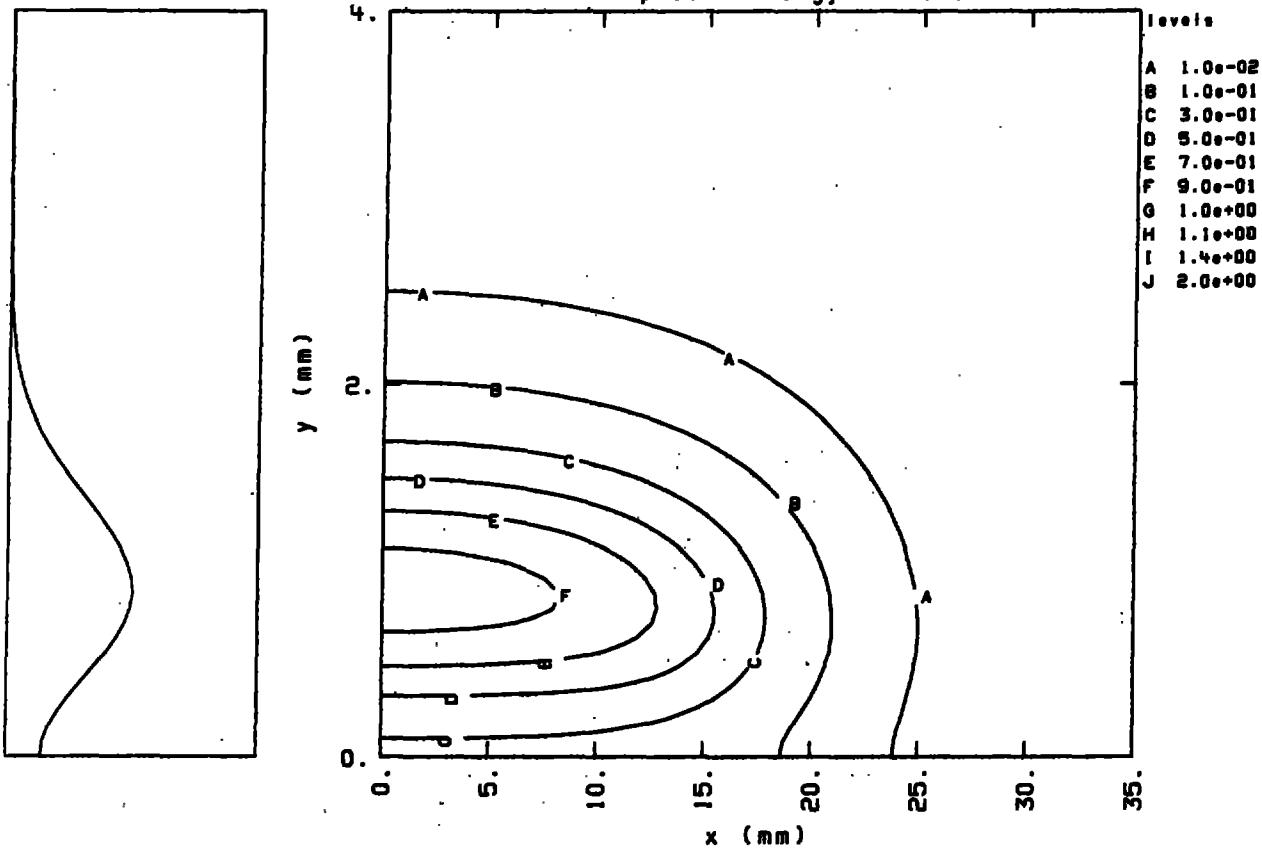


Fig. B9.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 3.40×10^0 GeV critical energy = 1.00×10^1 keV
 photon energy = 1.00×10^1 keV



perpendicular
polarization

normalized to
 $z = 9.42 \times 10^9$
 at $x = 0.$
 $y = 8.80 \times 10^{-1}$

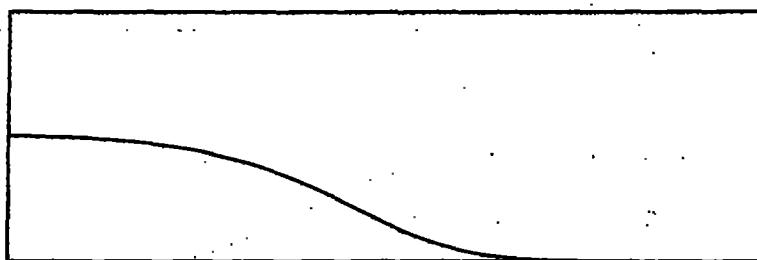


Fig. B9.6.

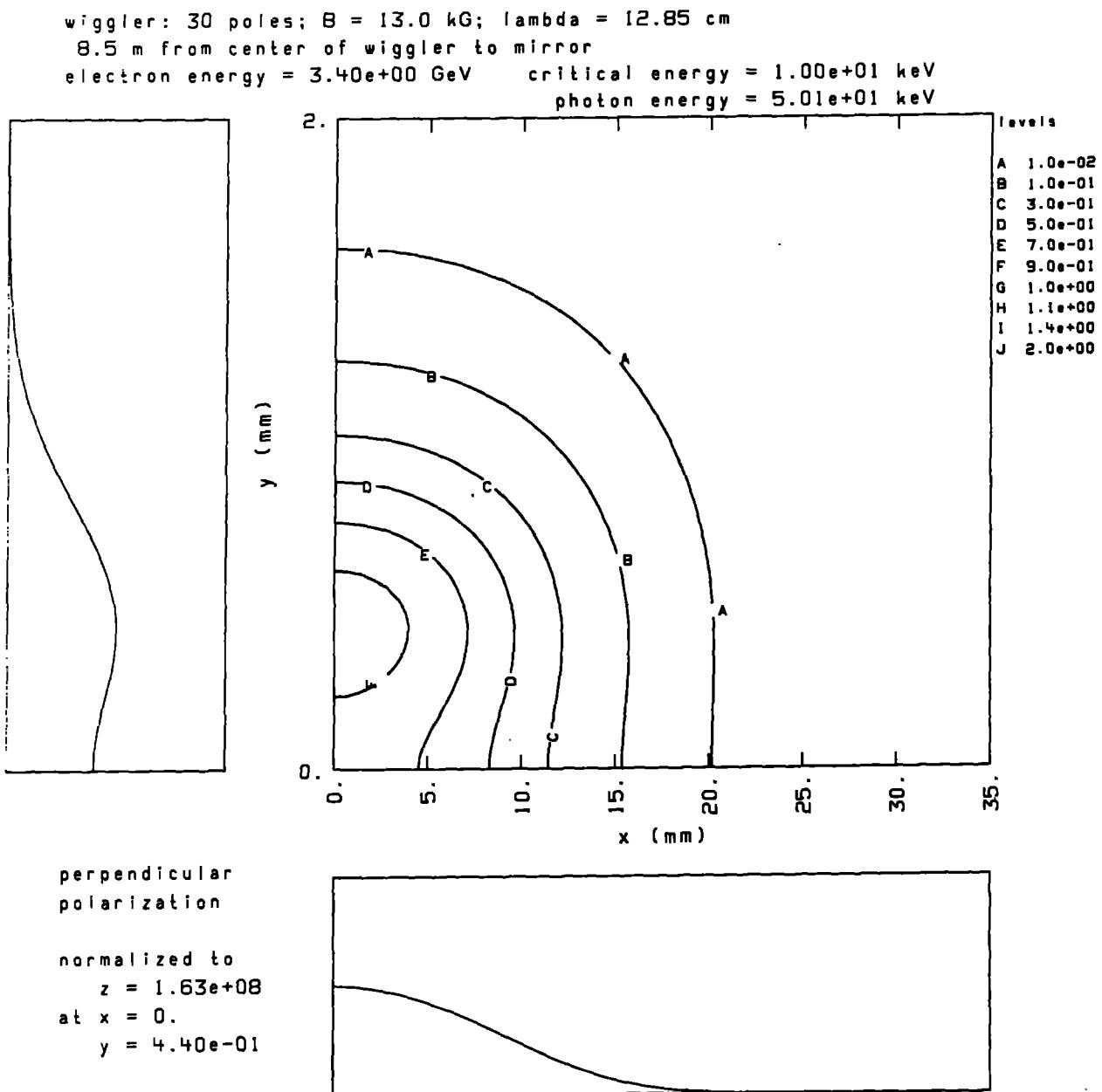


Fig. B9.7.

APPENDIX C

TABLES OF INTEGRATED ABSOLUTE NUMBERS OF PHOTONS

List of tables:

Total intensity for $E = 1.8 \text{ GeV}$ ($\epsilon_c = 2.80 \text{ keV}$)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C1.1	20 eV	83
C1.2	100 eV	84
C1.3	500 eV	85
C1.4	1 keV	86
C1.5	$\epsilon_c/2$	87
C1.6	ϵ_c	88
C1.7	$5\epsilon_c$	89

Parallel polarization intensity for $E = 1.8 \text{ GeV}$ ($\epsilon_c = 2.80 \text{ keV}$)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C2.1	20 eV	90
C2.2	100 eV	91
C2.3	500 eV	92
C2.4	1 keV	93
C2.5	$\epsilon_c/2$	94
C2.6	ϵ_c	95
C2.7	$5\epsilon_c$	96

Perpendicular polarization intensity for $E = 1.8 \text{ GeV}$ ($\epsilon_c = 2.80 \text{ keV}$)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C3.1	20 eV	97
C3.2	100 eV	98
C3.3	500 eV	99
C3.4	1 keV	100
C3.5	$\epsilon_c/2$	101
C3.6	ϵ_c	102
C3.7	$5\epsilon_c$	103

Total intensity for $E = 3.0 \text{ GeV}$ ($\epsilon_c = 7.78 \text{ keV}$)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C4.1	20 eV	104
C4.2	100 eV	105
C4.3	500 eV	106
C4.4	1 keV	107
C4.5	$\epsilon_c/2$	108
C4.6	ϵ_c	109
C4.7	$5\epsilon_c$	110

Parallel polarization intensity for E = 3.0 GeV (ϵ_c = 7.78 keV)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C5.1	20 eV	111
C5.2	100 eV	112
C5.3	500 eV	113
C5.4	1 keV	114
C5.5	$\epsilon_c/2$	115
C5.6	ϵ_c	116
C5.7	$5\epsilon_c$	117

Perpendicular polarization intensity for E = 3.0 GeV (ϵ_c = 7.78 keV)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C6.1	20 eV	118
C6.2	100 eV	119
C6.3	500 eV	120
C6.4	1 keV	121
C6.5	$\epsilon_c/2$	122
C6.6	ϵ_c	123
C6.7	$5\epsilon_c$	124

Total intensity for E = 3.4 GeV (ϵ_c = 10.00 keV)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C7.1	20 eV	125
C7.2	100 eV	126
C7.3	500 eV	127
C7.4	1 keV	128
C7.5	$\epsilon_c/2$	129
C7.6	ϵ_c	130
C7.7	$5\epsilon_c$	131

Parallel polarization intensity for E = 3.4 GeV (ϵ_c = 10.00 keV)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C8.1	20 eV	132
C8.2	100 eV	133
C8.3	500 eV	134
C8.4	1 keV	135
C8.5	$\epsilon_c/2$	136
C8.6	ϵ_c	137
C8.7	$5\epsilon_c$	138

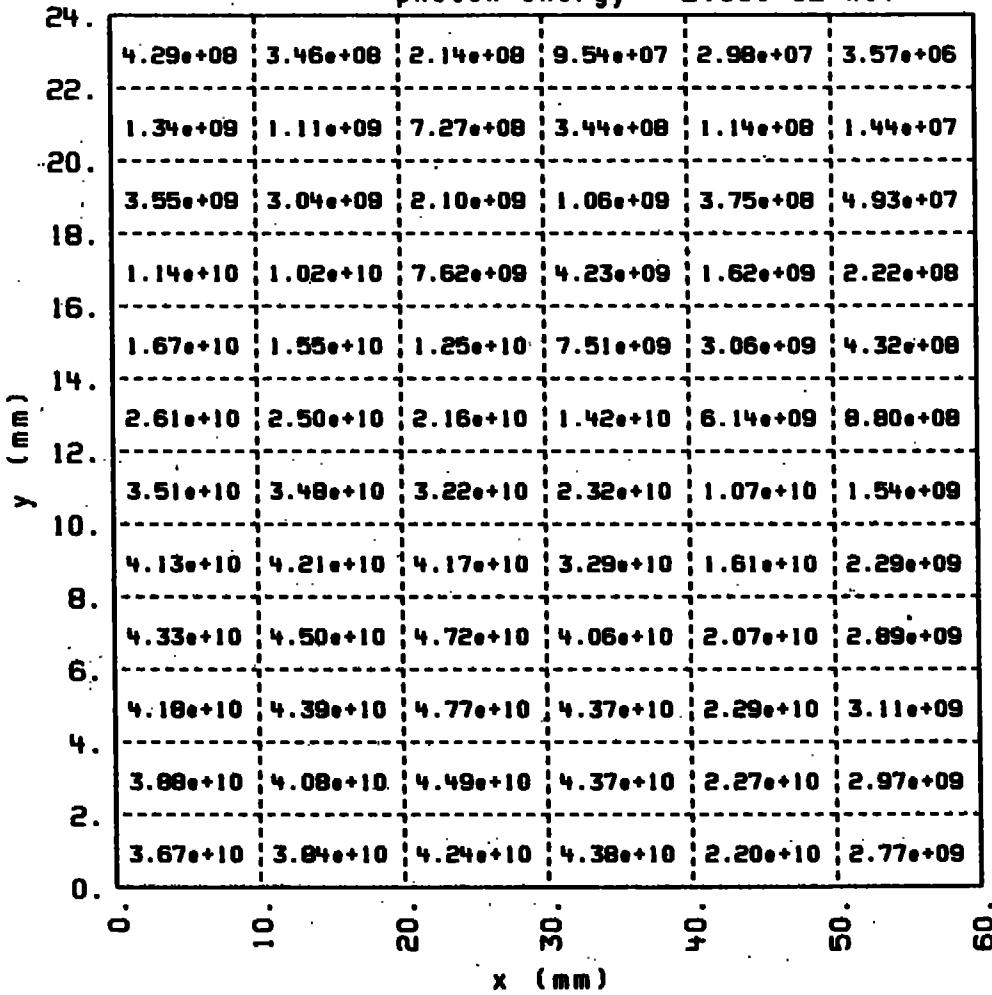
Perpendicular polarization intensity for E = 3.4 GeV (ϵ_c = 10.00 keV)

<u>Table</u>	<u>Photon Energy</u>	<u>Page</u>
C9.1	20 eV	139
C9.2	100 eV	140
C9.3	500 eV	141
C9.4	1 keV	142
C9.5	$\epsilon_c/2$	143
C9.6	ϵ_c	144
C9.7	$5\epsilon_c$	145

Table C1.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $2.00e-02$ keV

photons/sec/mA in 0.1% bandwidth

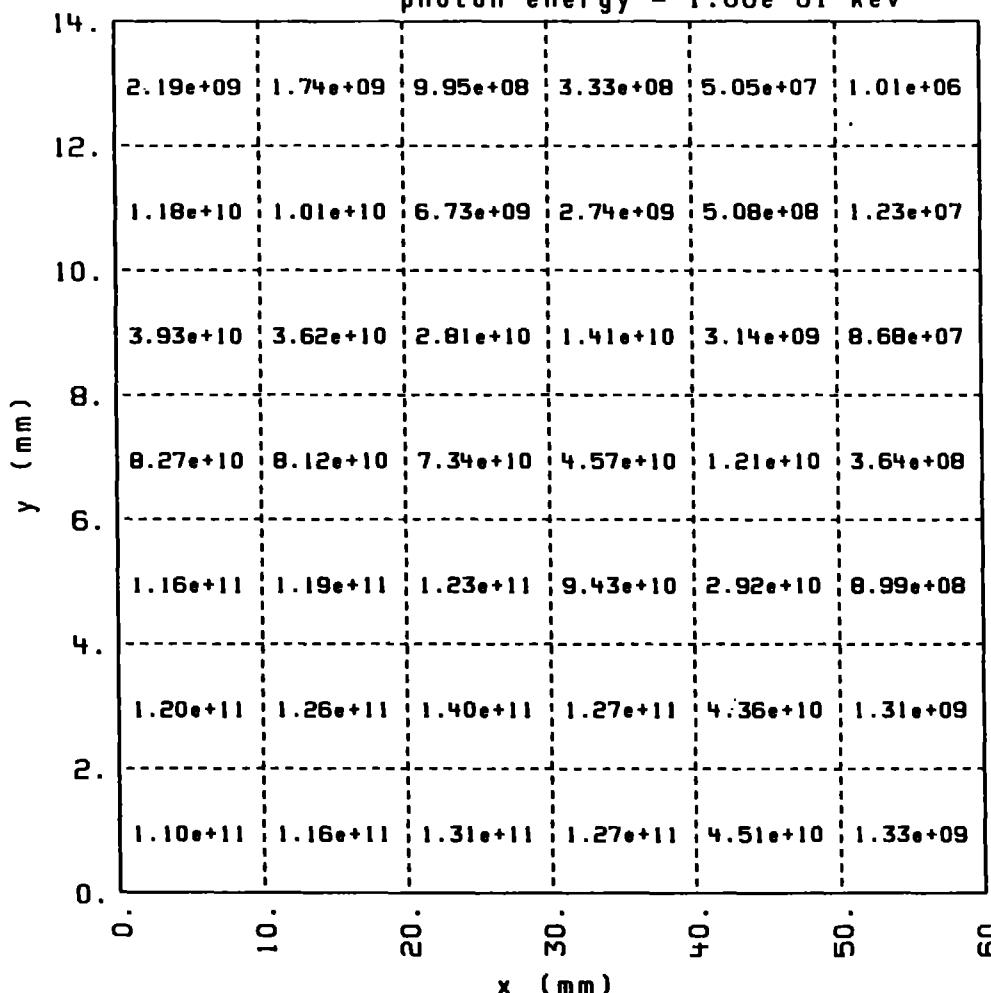
Table C1.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 1.80e+00 GeV critical energy = 2.80e+00 keV

photon energy = 1.00e-01 keV



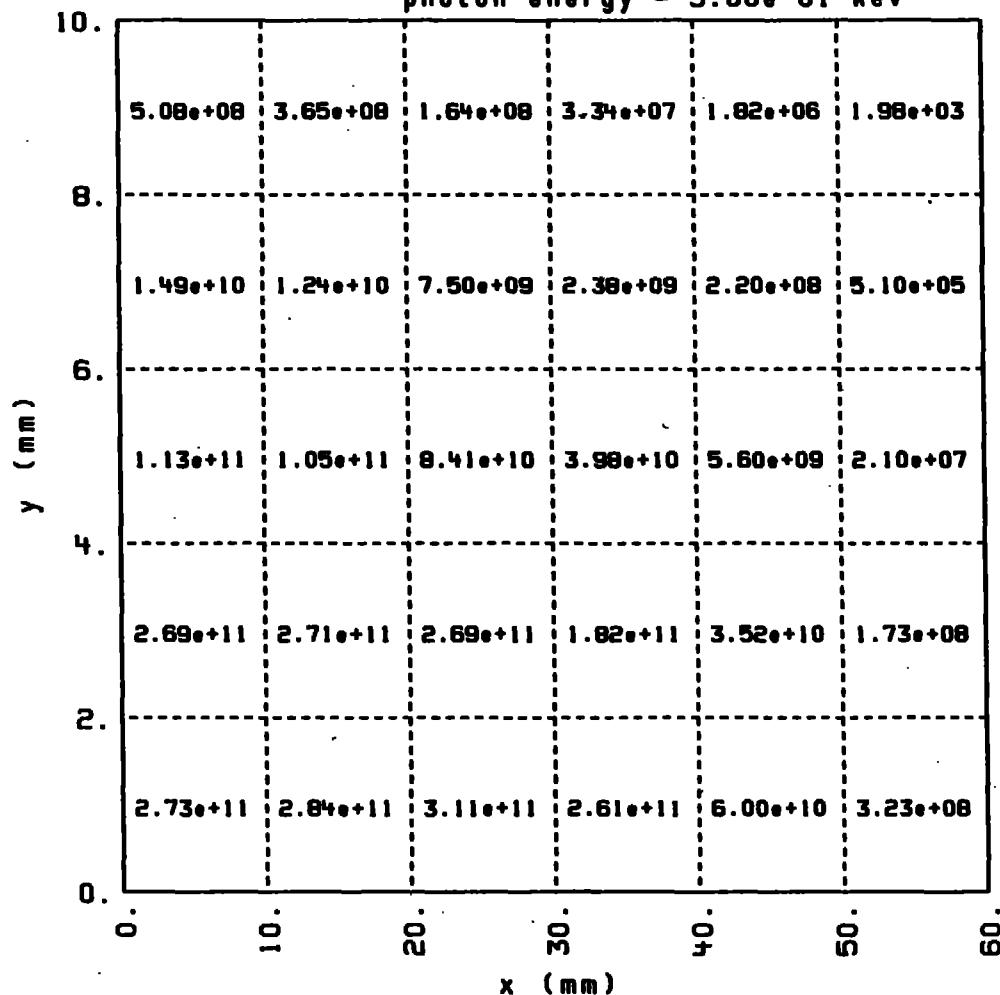
photons/sec/mA in 0.1% bandwidth

Table C1.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $5.00e-01$ keV



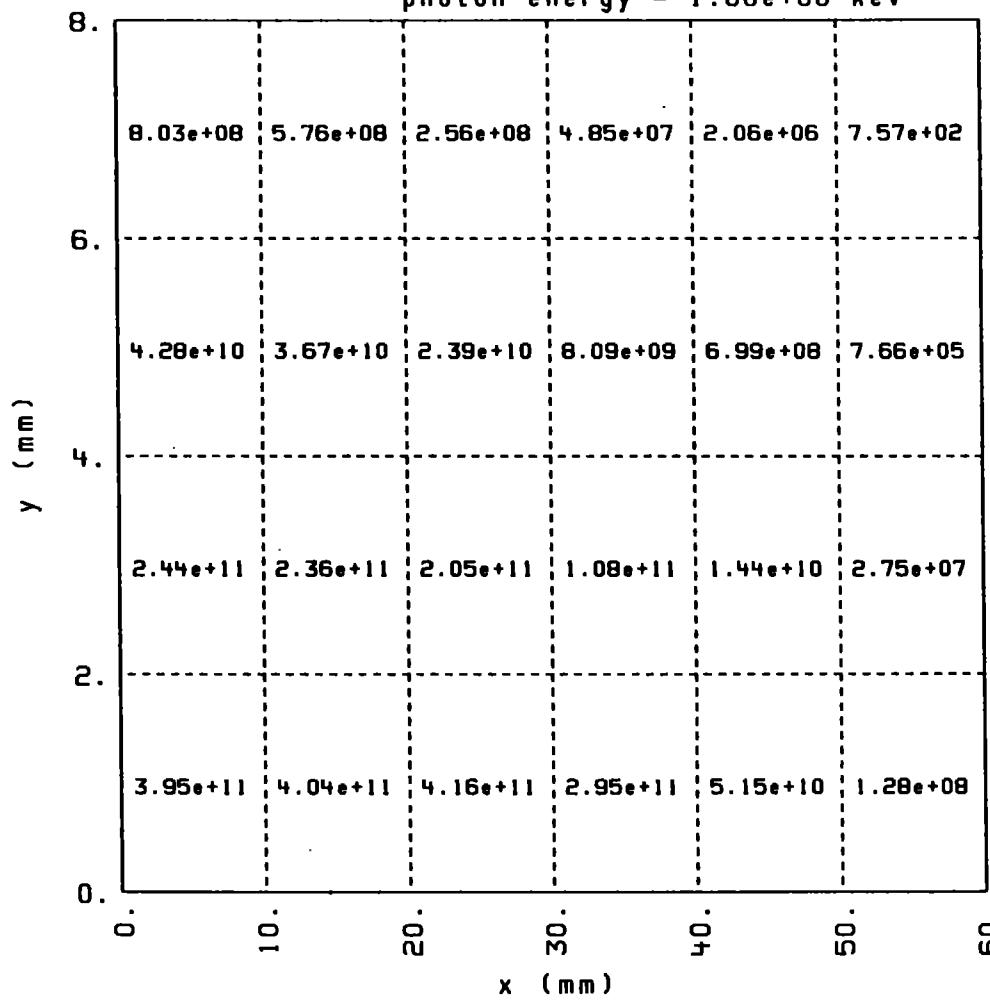
photons/sec/mA in 0.1% bandwidth

Table C1.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.00e+00$ keV



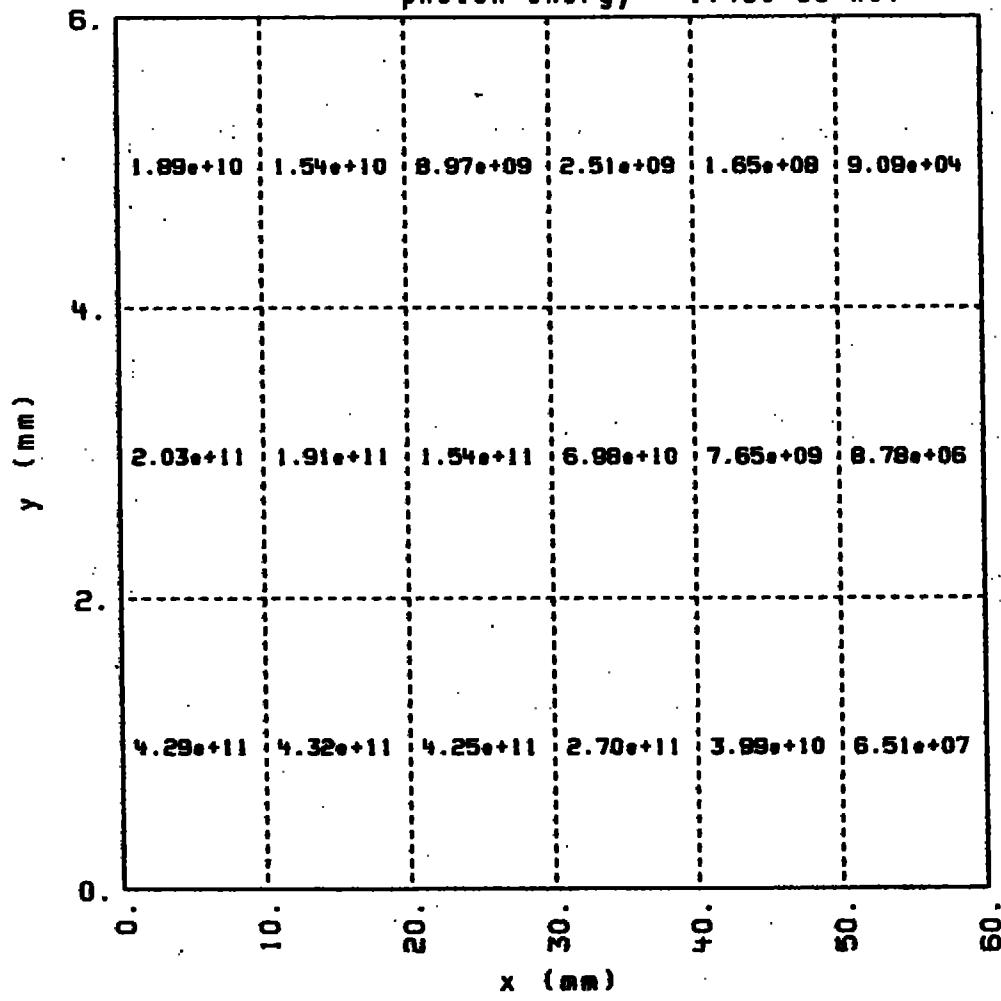
photons/sec/mA in 0.1% bandwidth

Table C1.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 1.80e+00 GeV critical energy = 2.80e+00 keV
photon energy = 1.40e+00 keV



photons/sec/mA in 0.1% bandwidth

Table C1.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $2.80e+00$ keV

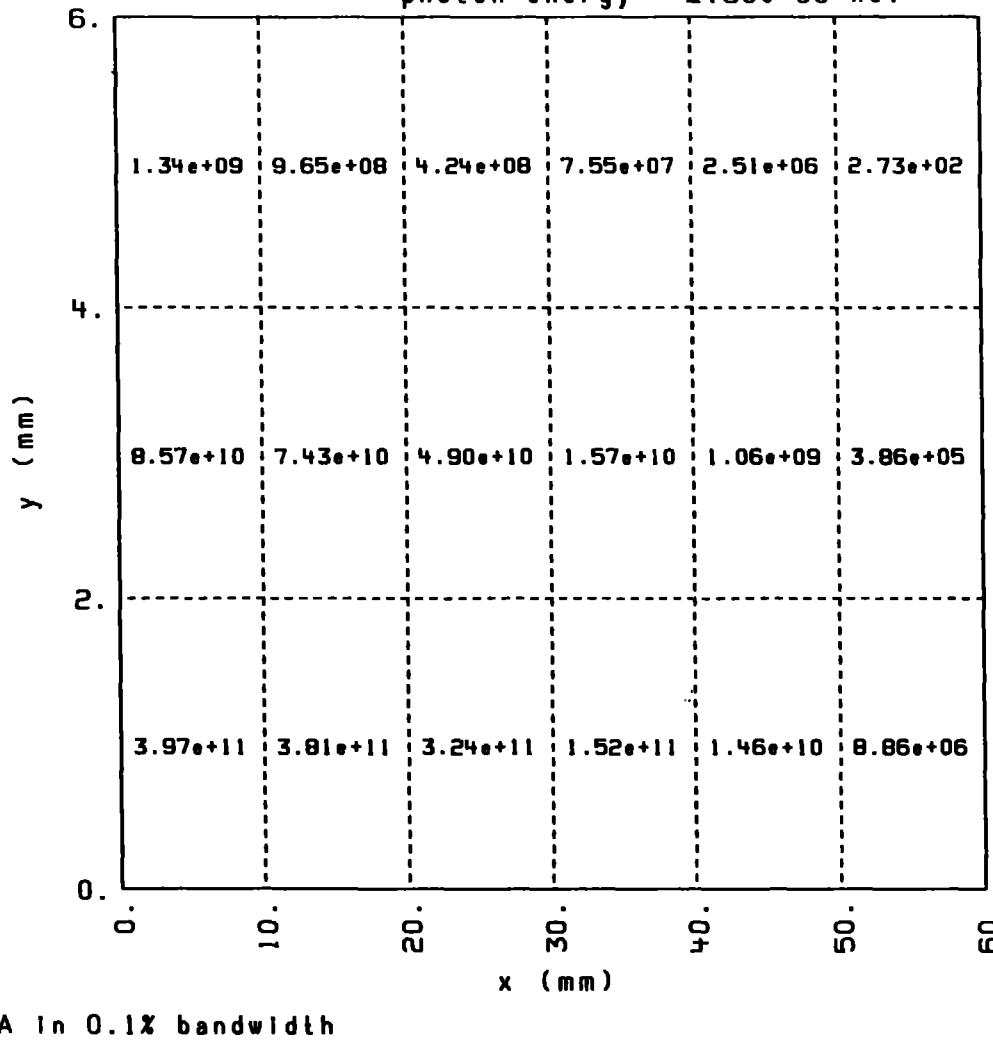
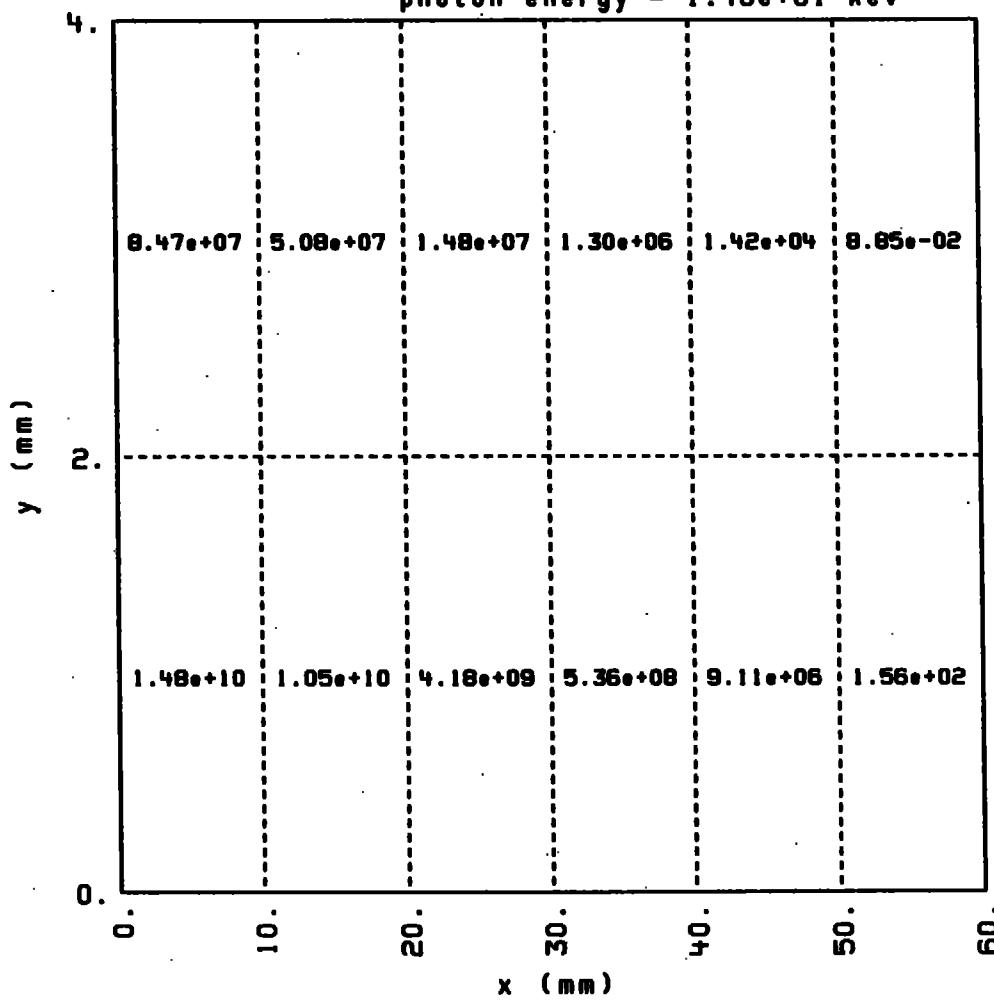


Table C1.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
 photon energy = $1.40e+01$ keV

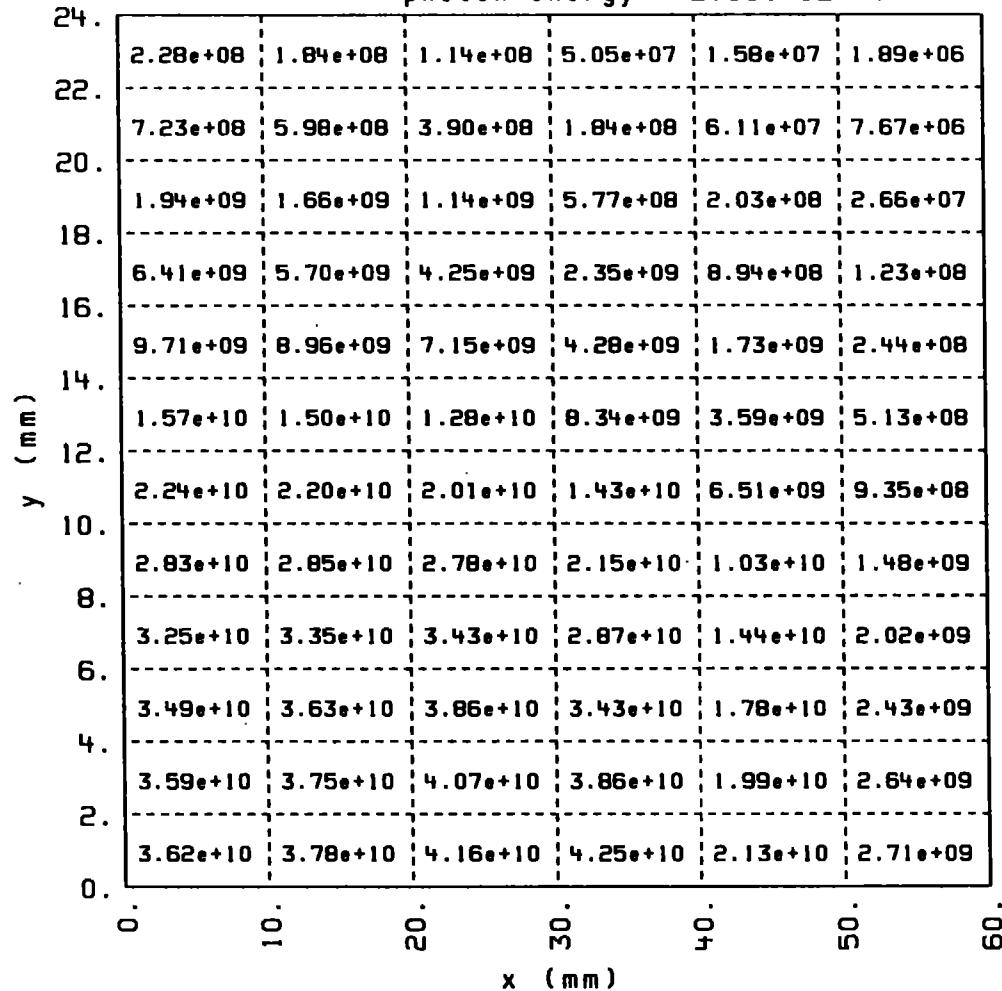


photons/sec/mA in 0.1% bandwidth

Table C2.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $2.00e-02$ keVparallel
polarization

photons/sec/mA in 0.1% bandwidth

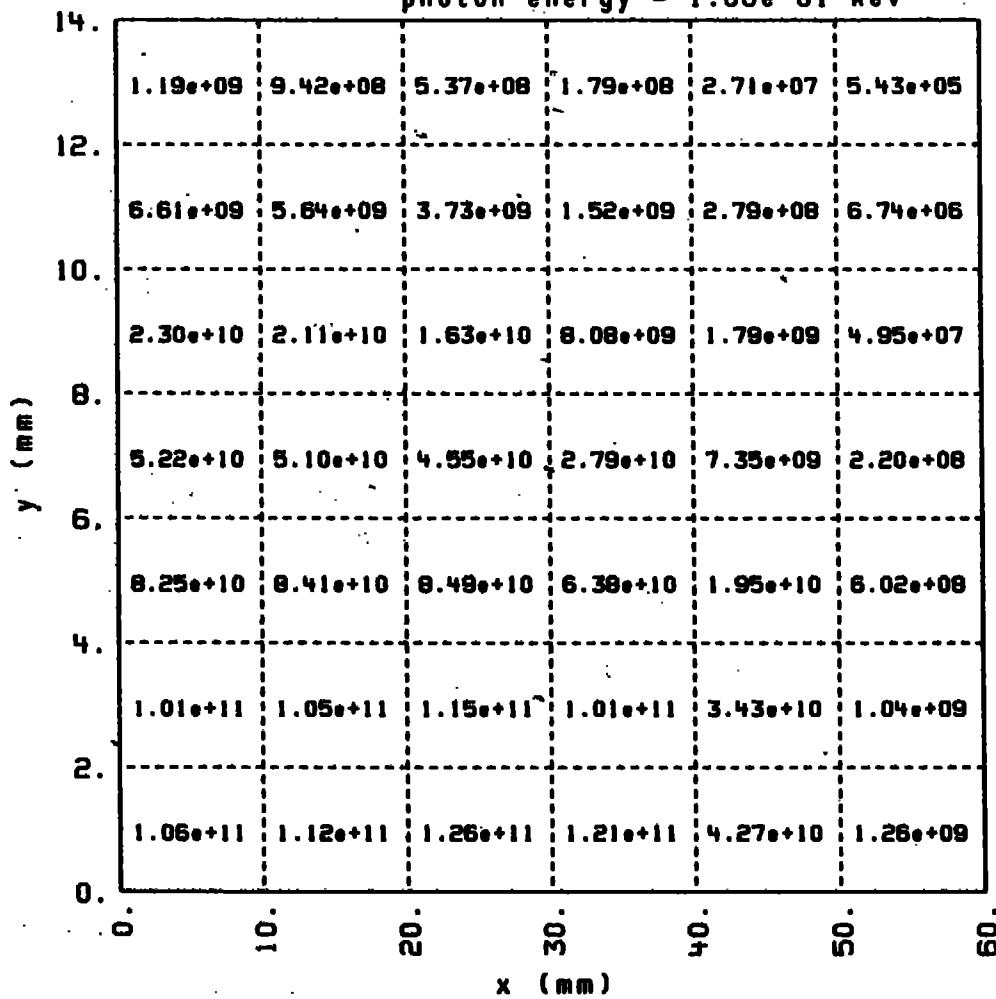
Table C2.2:

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 1.80e+00 GeV critical energy = 2.80e+00 keV

photon energy = 1.00e-01 keV



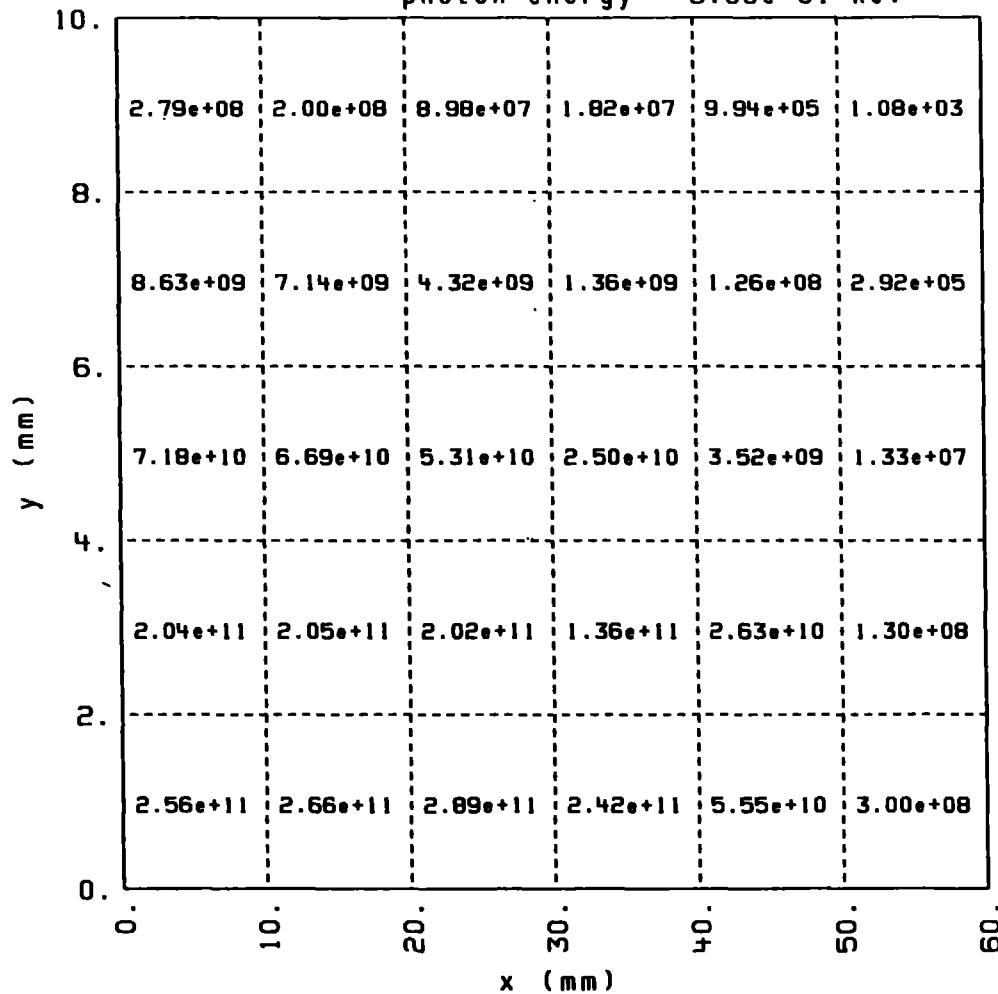
parallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C2.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keVphoton energy = $5.00e-01$ keVparallel
polarization

photons/sec/mA in 0.1% bandwidth

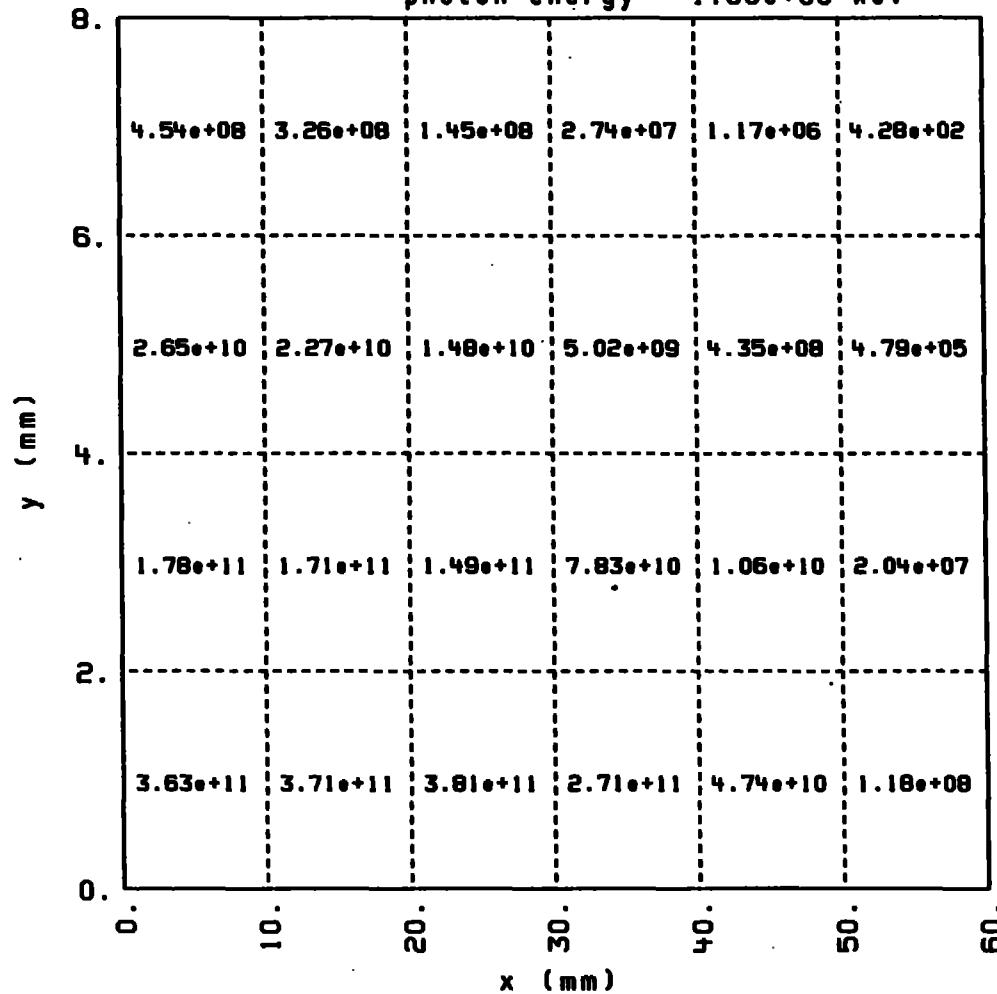
Table C2.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV

photon energy = $1.00e+00$ keV



parallel
polarization

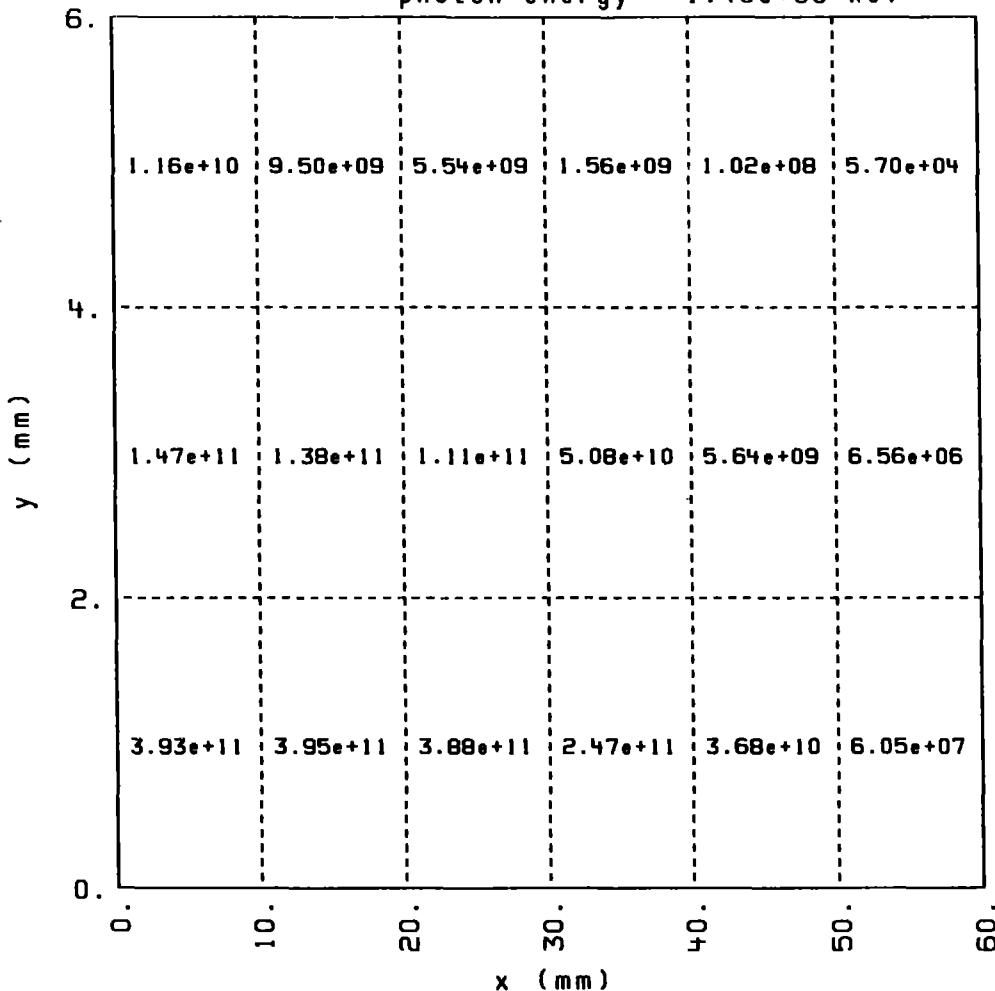
photons/sec/mA in 0.1% bandwidth

Table C2.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $1.40e+00$ keV



parallel
polarization

photons/sec/mA in 0.1% bandwidth

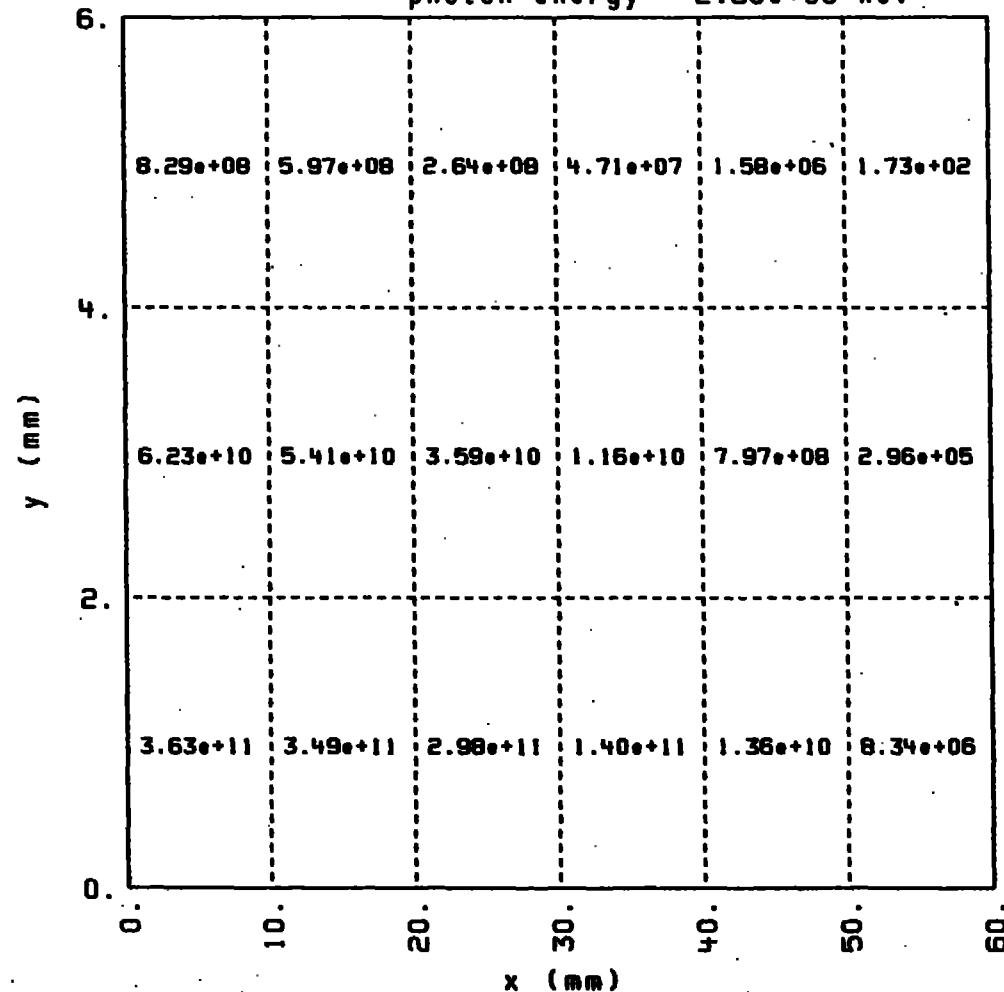
Table C2.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV

photon energy = $2.80e+00$ keV

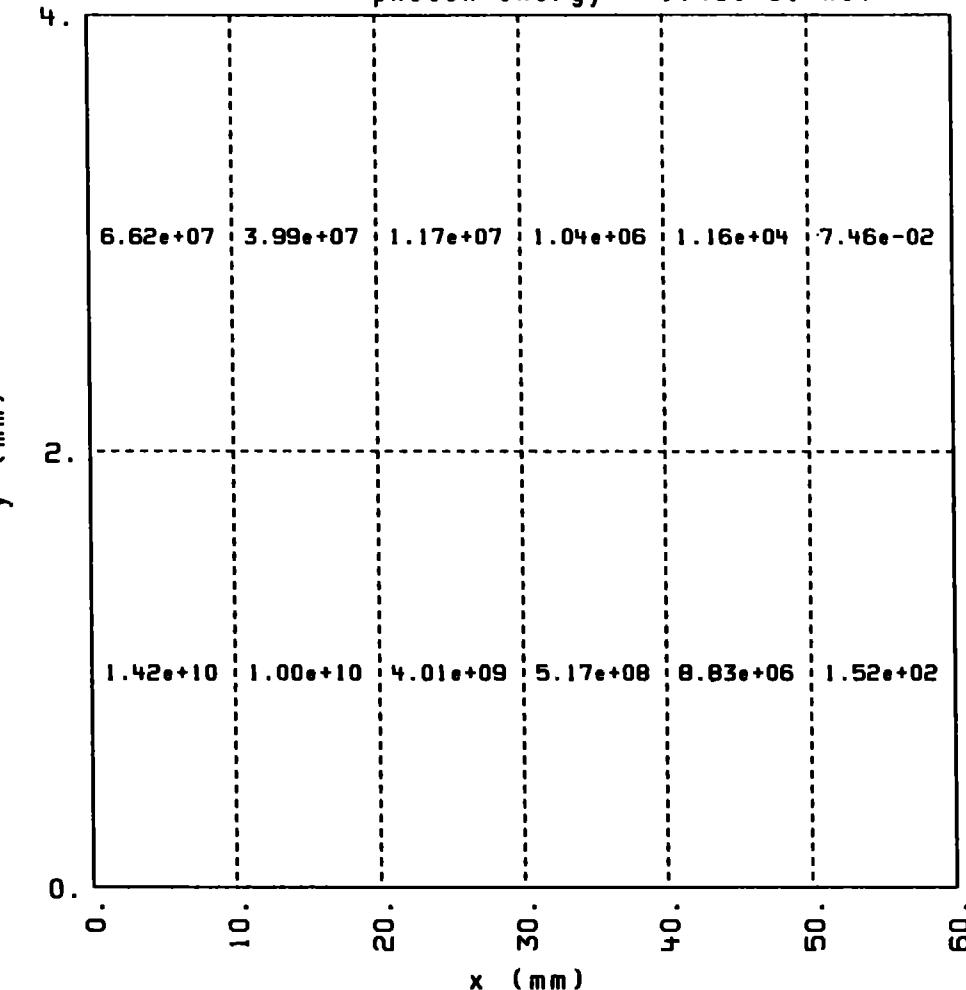


parallel
polarization

— photons/sec/mA in 0.1% bandwidth

Table C2.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm
 8.5 m from center of wiggler to mirror
 electron energy = 1.80e+00 GeV critical energy = 2.80e+00 keV
 photon energy = 1.40e+01 keV



parallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C3.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

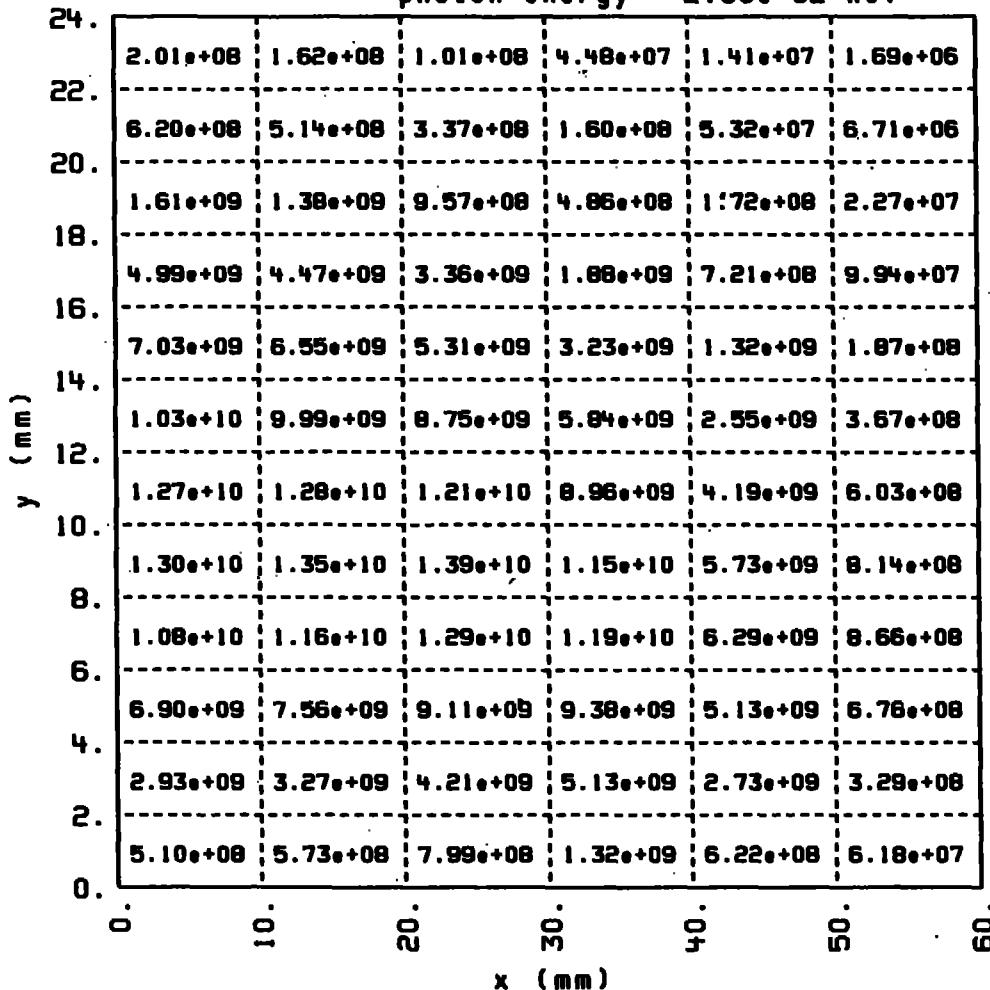
electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $2.00e-02$ keVperpendicular
polarizationphotons/sec/mA: In 0.1% bandwidth

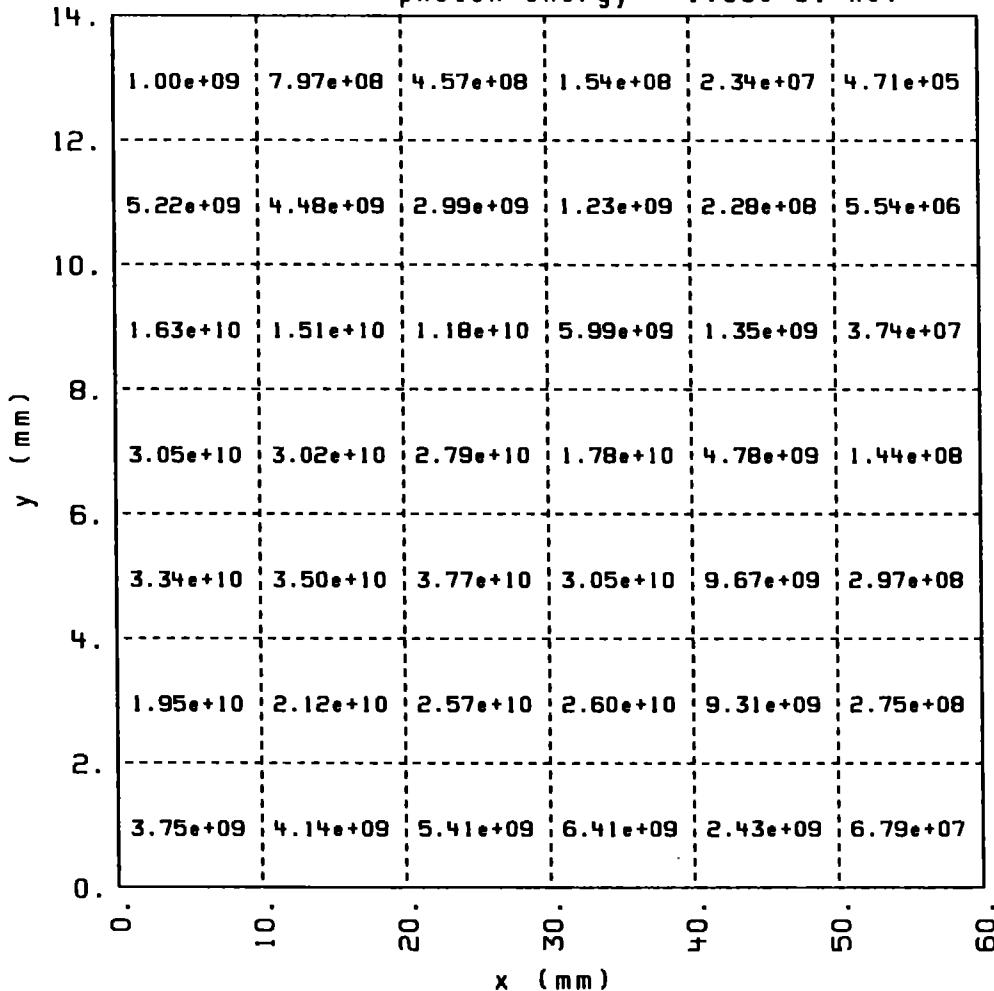
Table C3.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV

photon energy = $1.00e-01$ keV



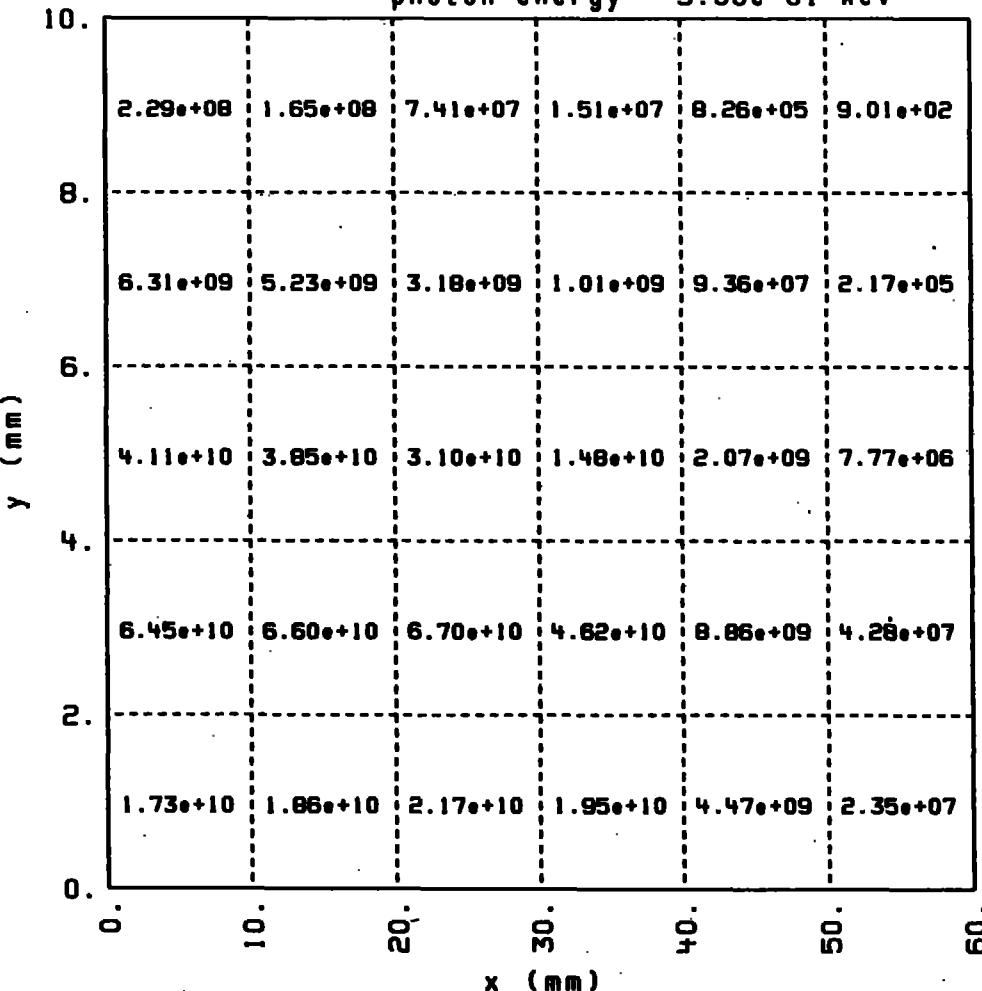
perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

Table C3.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keVphoton energy = $5.00e-01$ keVperpendicular
polarization

photons/sec/mA in 0.1% bandwidth

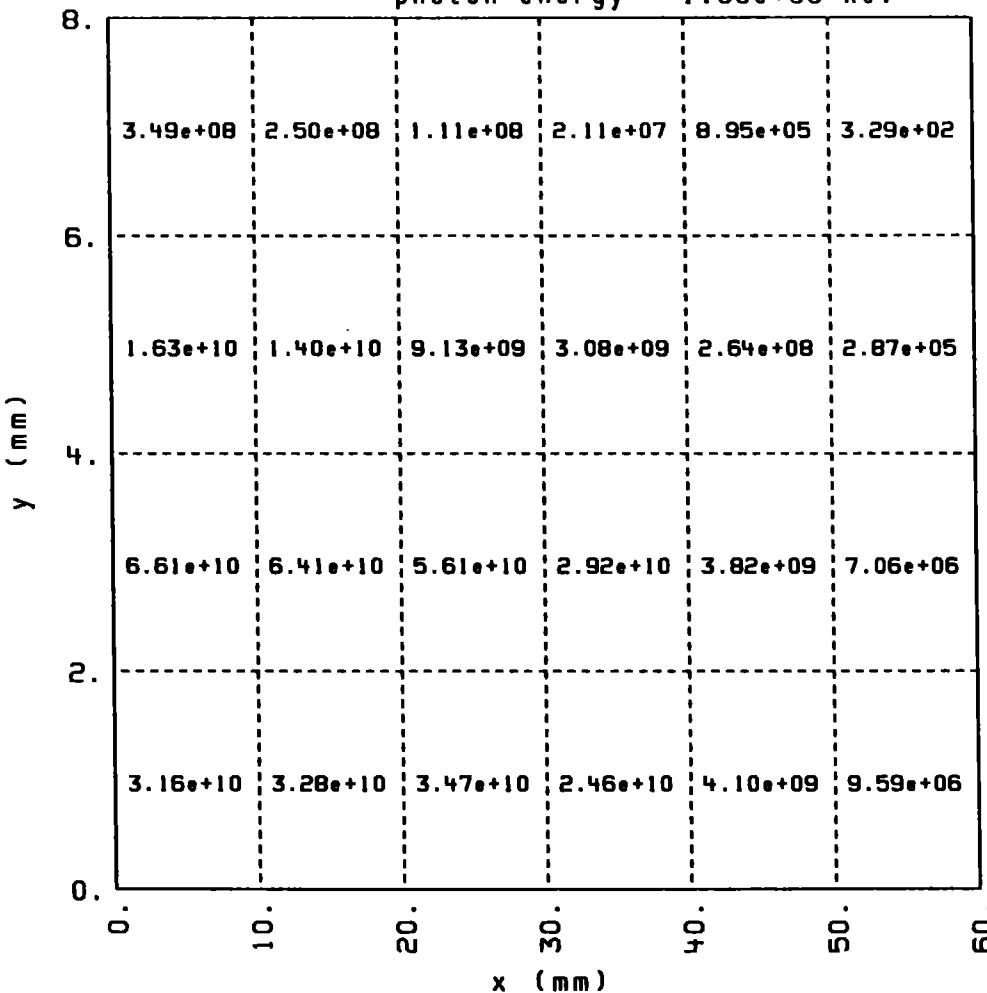
Table C3.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV

photon energy = $1.00e+00$ keV



perpendicular
polarization

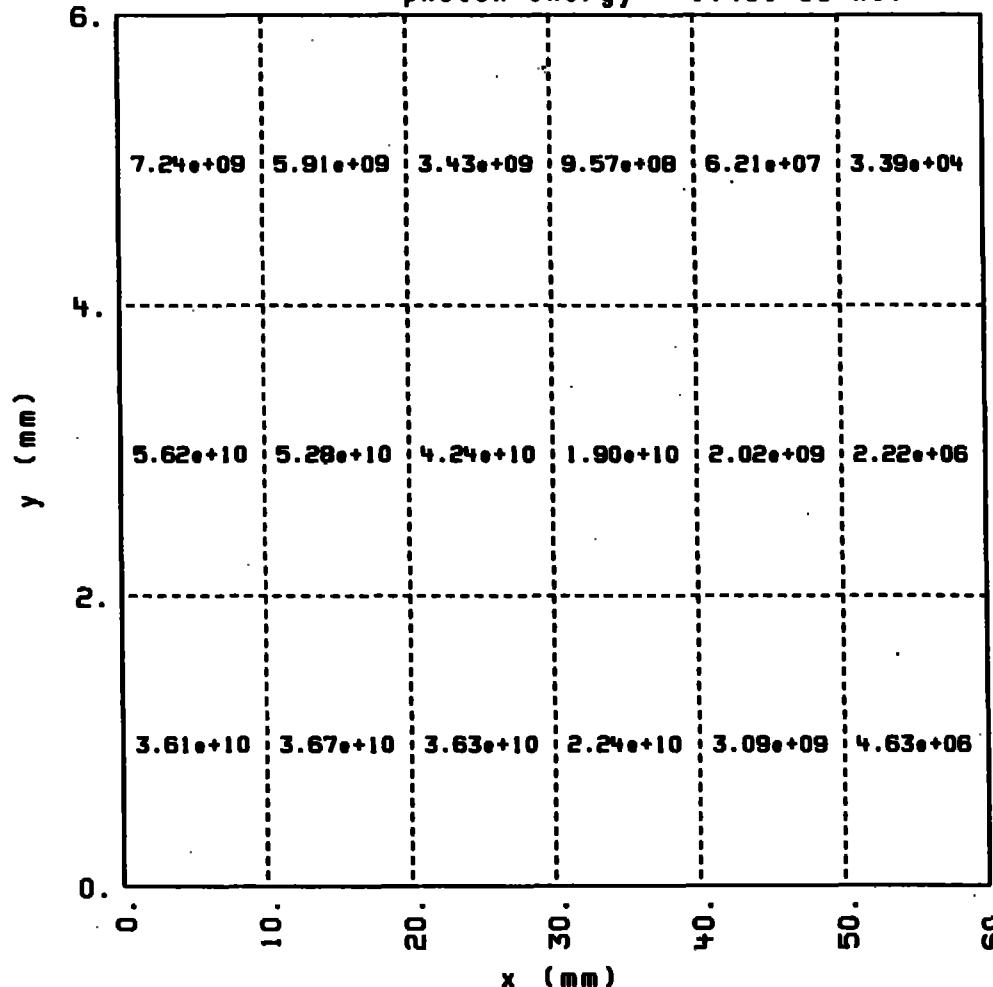
photons/sec/mA in 0.1% bandwidth

Table C3.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $1.40e+00$ keV



perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

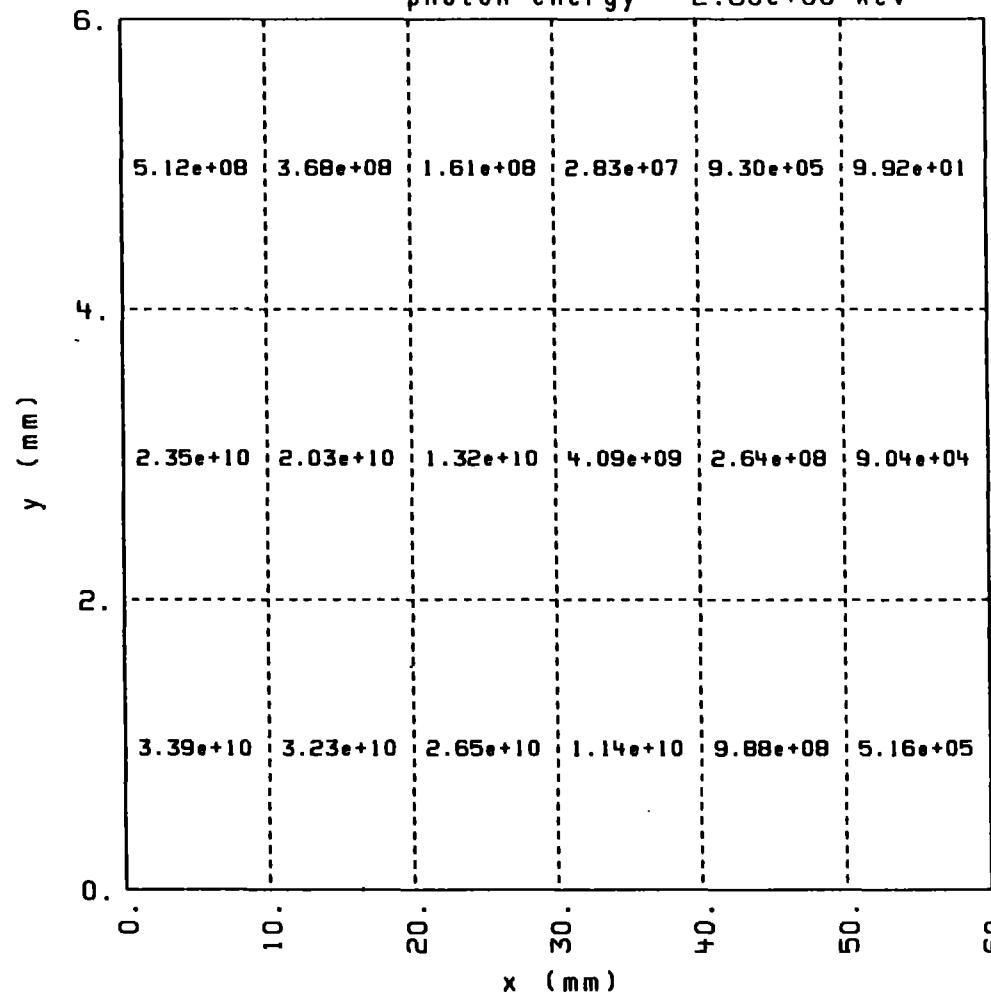
Table C3.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 1.80e+00 GeV critical energy = 2.80e+00 keV

photon energy = 2.80e+00 keV



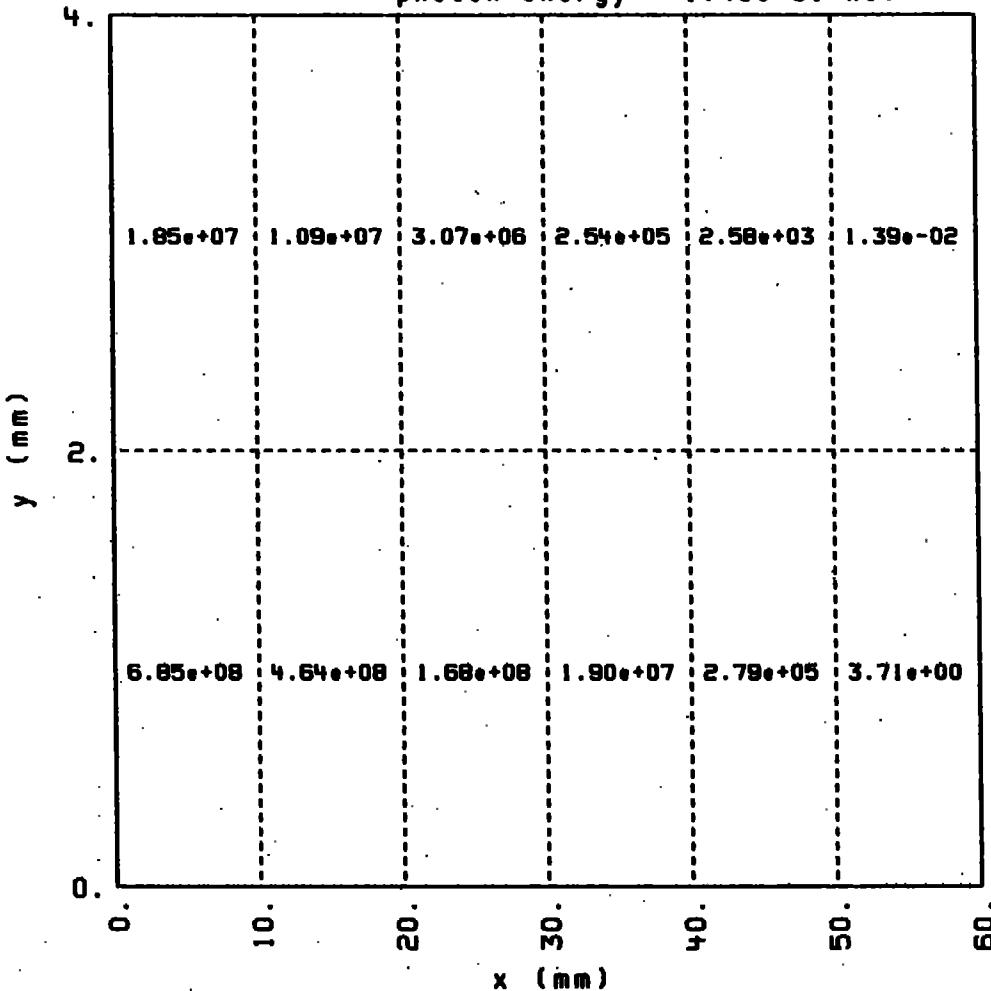
perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

Table C3.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $1.80e+00$ GeV critical energy = $2.80e+00$ keV
photon energy = $1.40e+01$ keVperpendicular
polarization

photons/sec/mA in 0.1% bandwidth

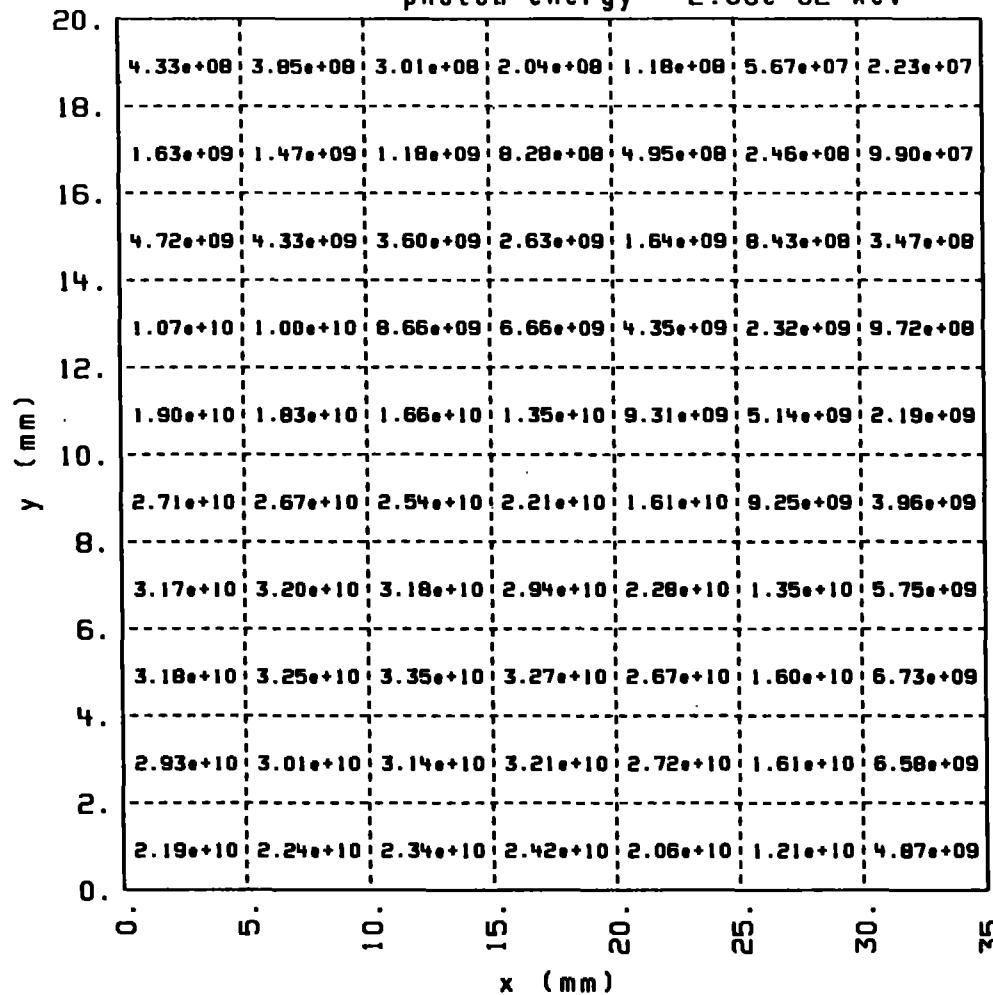
Table C4.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 2.00e-02 keV



photons/sec/mA in 0.1% bandwidth

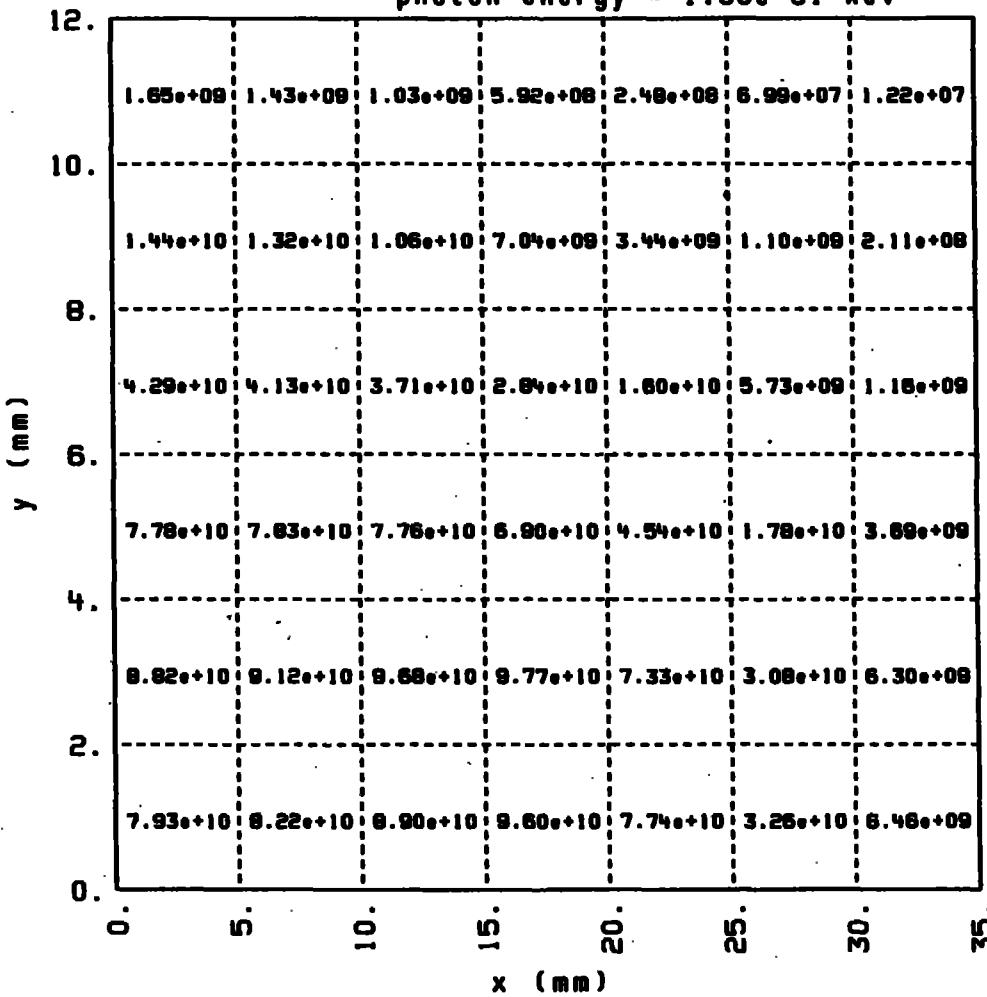
Table C4.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV

photon energy = $1.00e-01$ keV



photons/sec/mA in 0.1% bandwidth

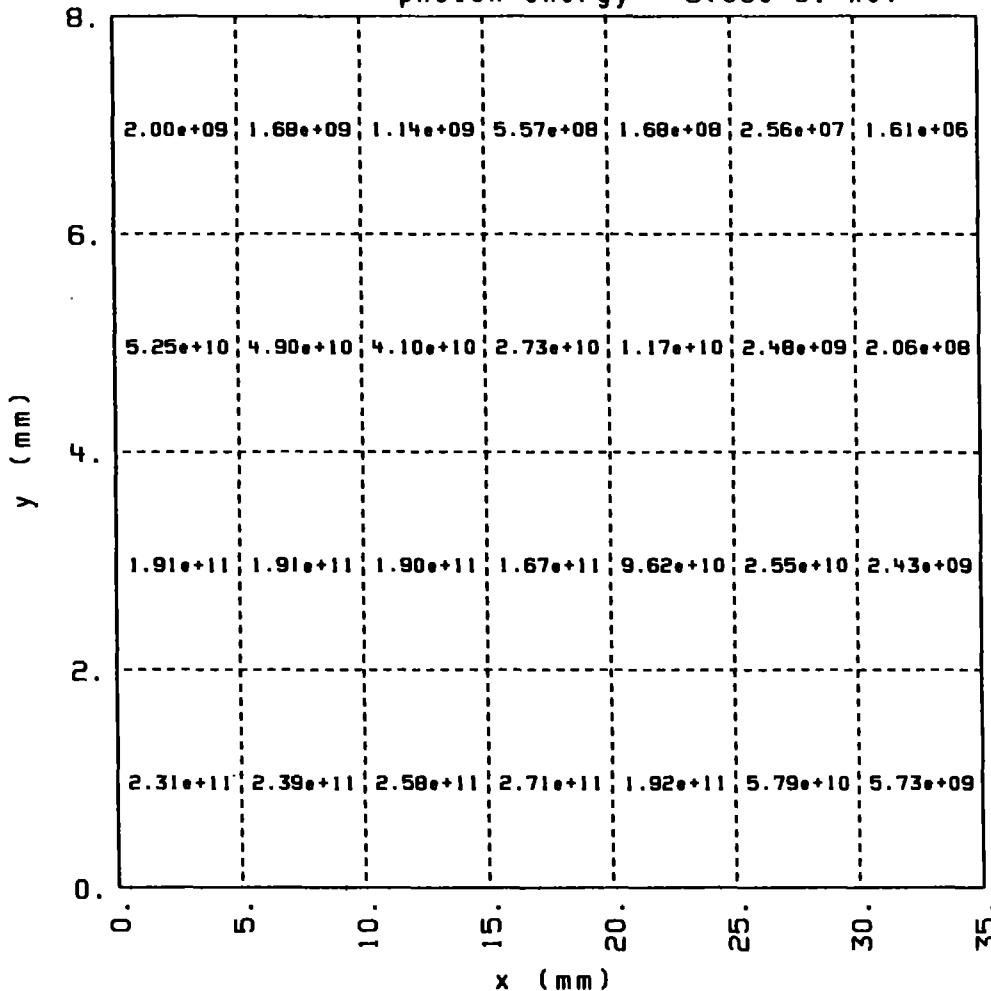
Table C4.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV

photon energy = $5.00e-01$ keV



photons/sec/mA in 0.1% bandwidth

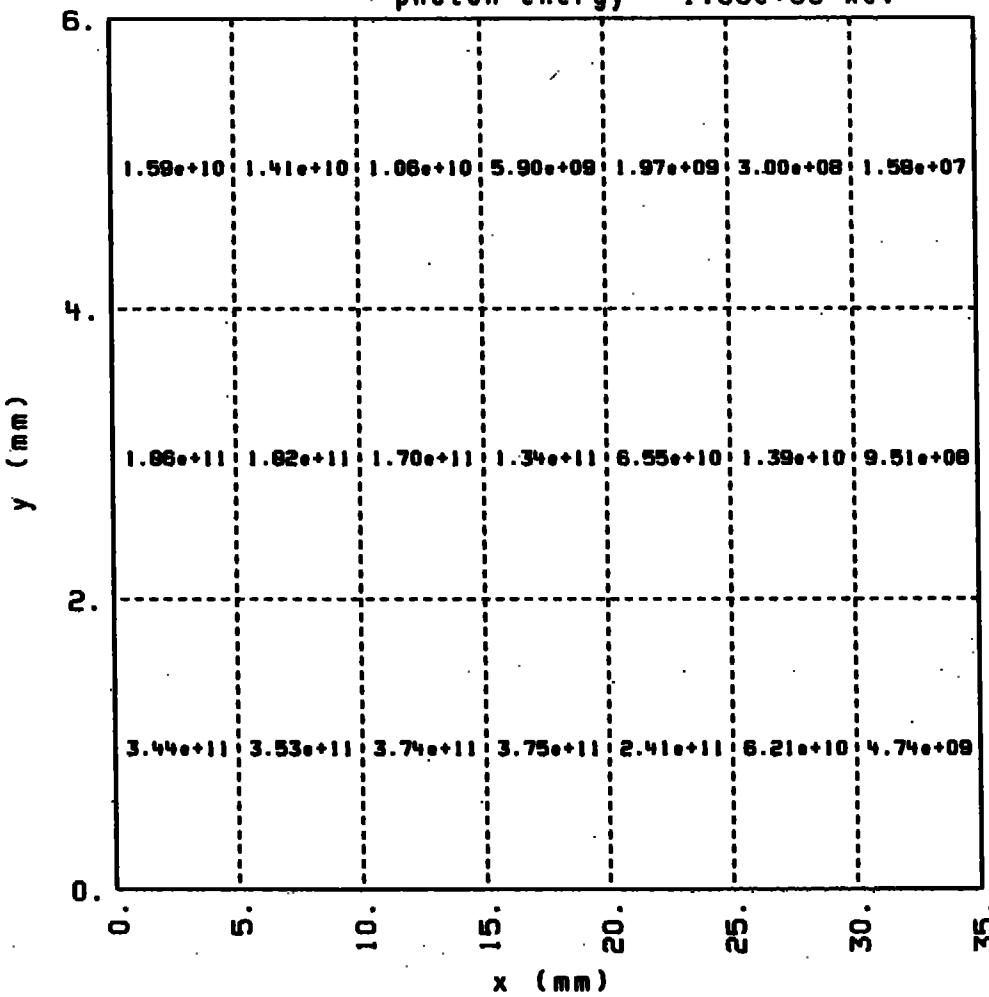
Table C4.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV

photon energy = $1.00e+00$ keV



photons/sec/mA in 0.1% bandwidth

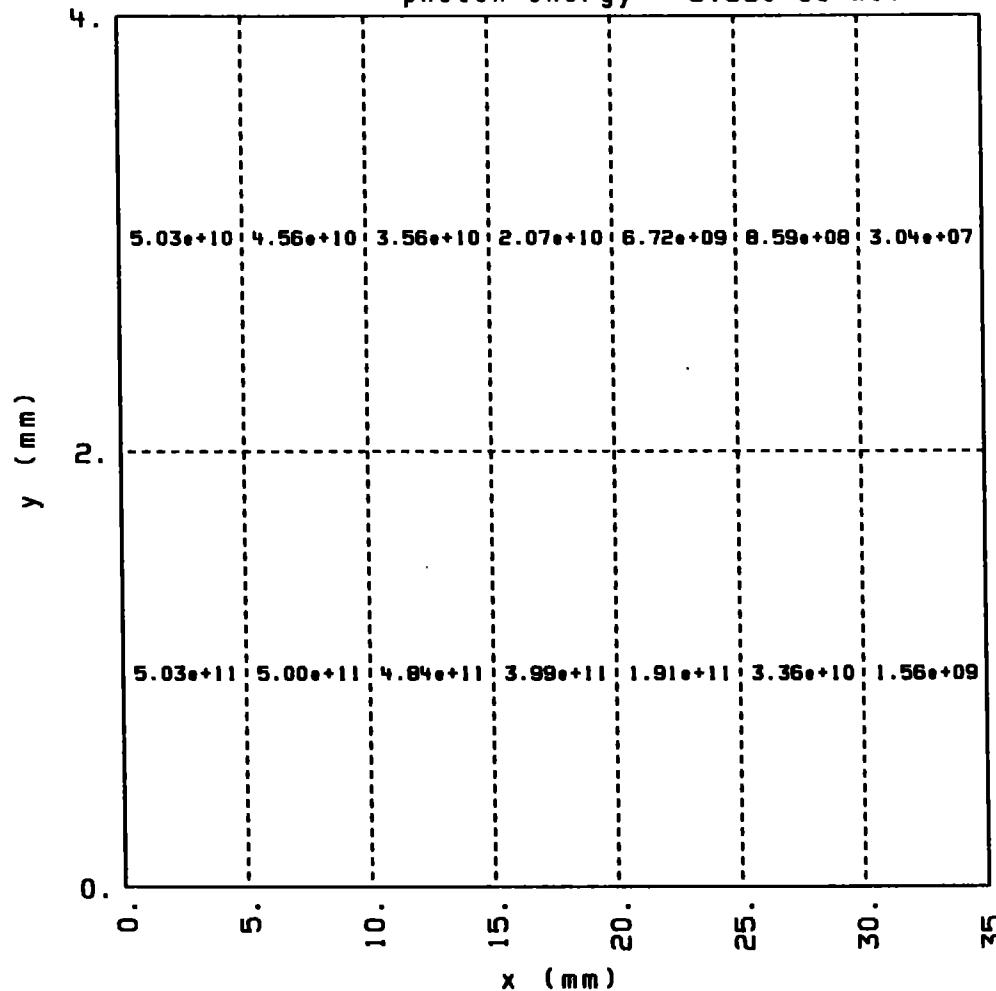
Table C4.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 3.89e+00 keV



photons/sec/mA in 0.1% bandwidth

Table C4.6.

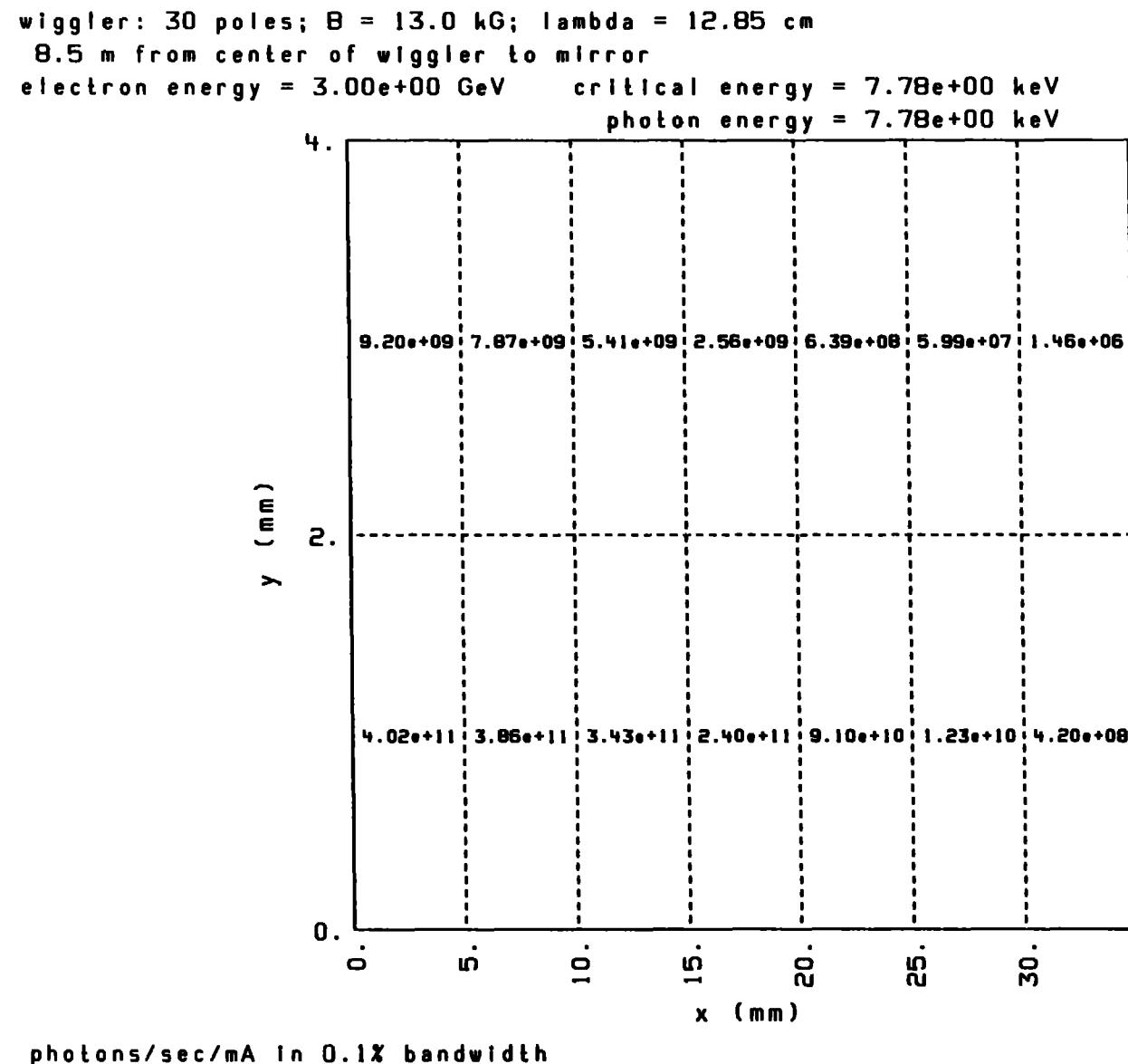


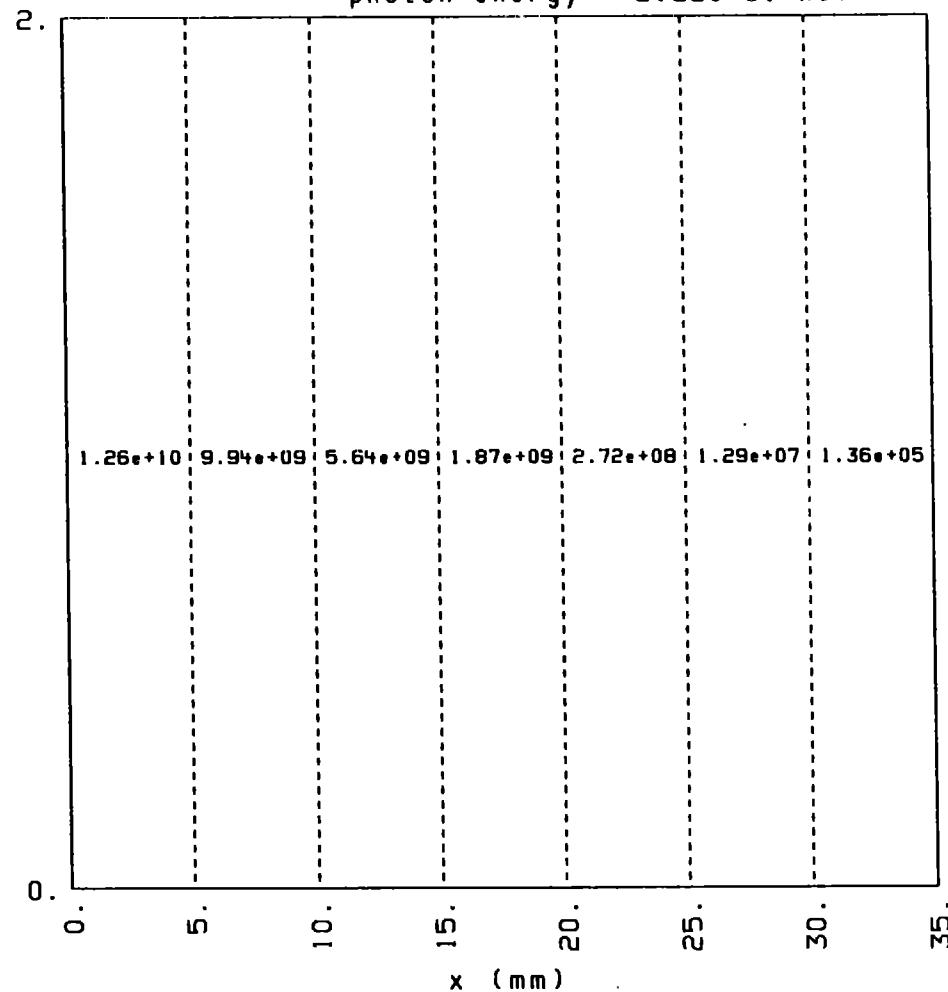
Table C4.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV

photon energy = $3.89e+01$ keV

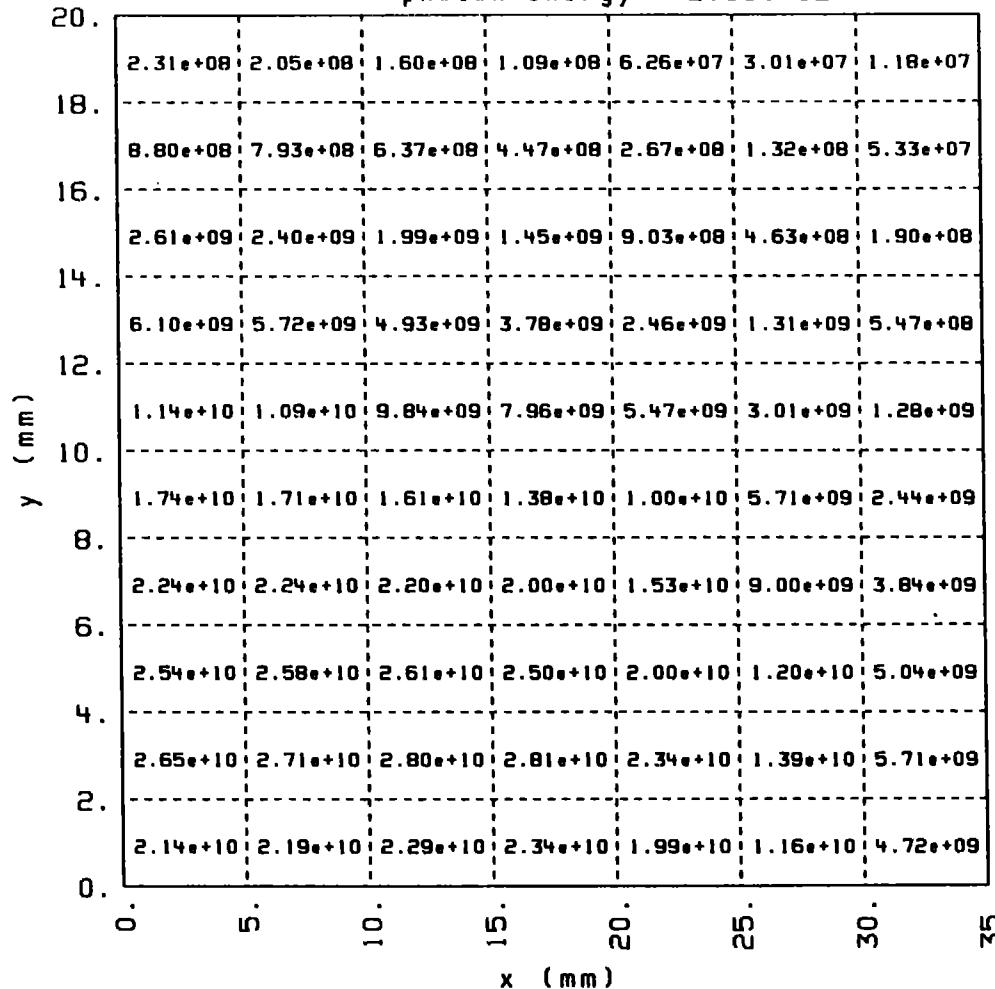


photons/sec/mA in 0.1% bandwidth

Table C5.1.

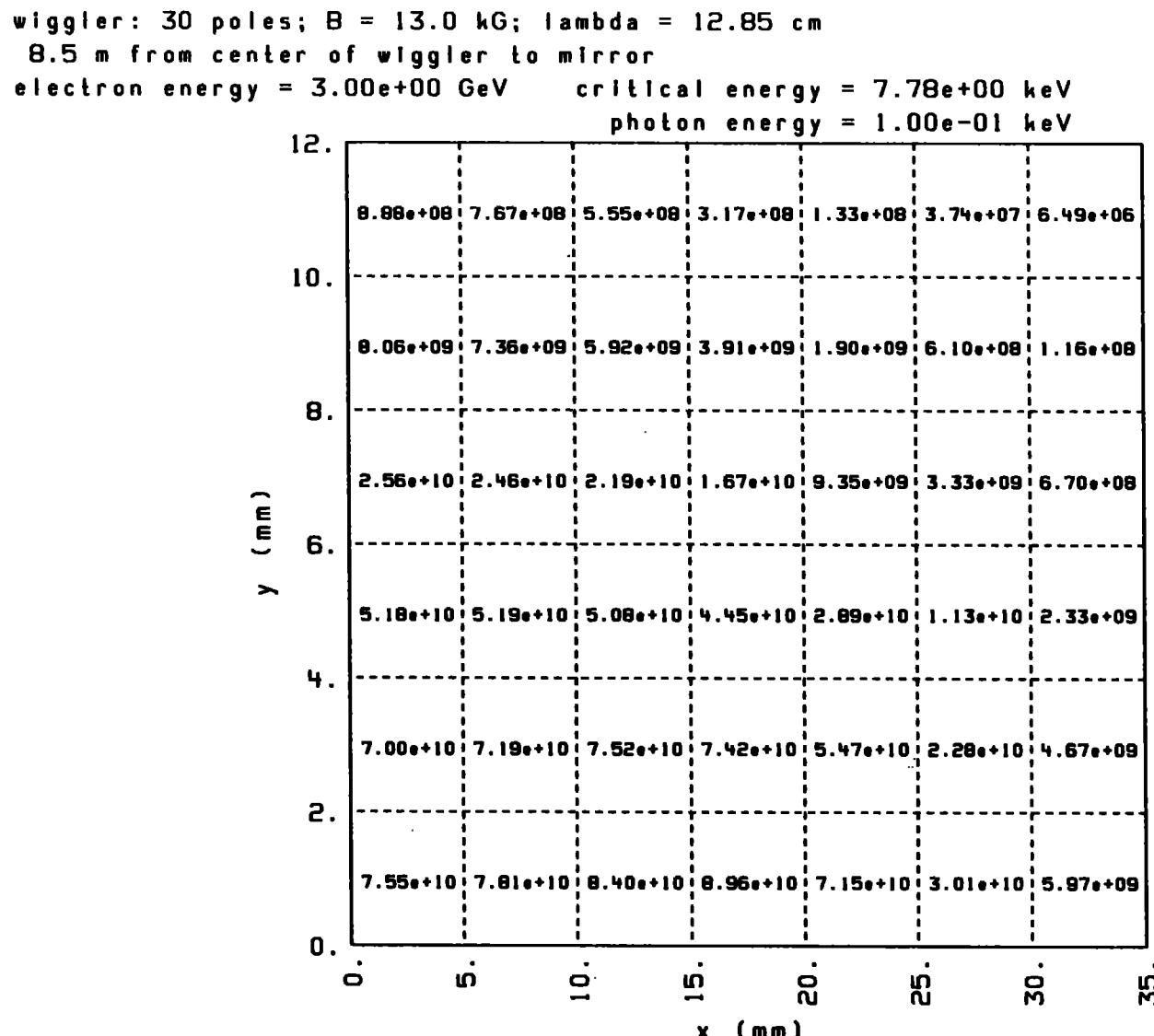
wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV
photon energy = 2.00e-02 keVparallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C5.2.



parallel
polarization

photons/sec/mA in 0.1% bandwidth

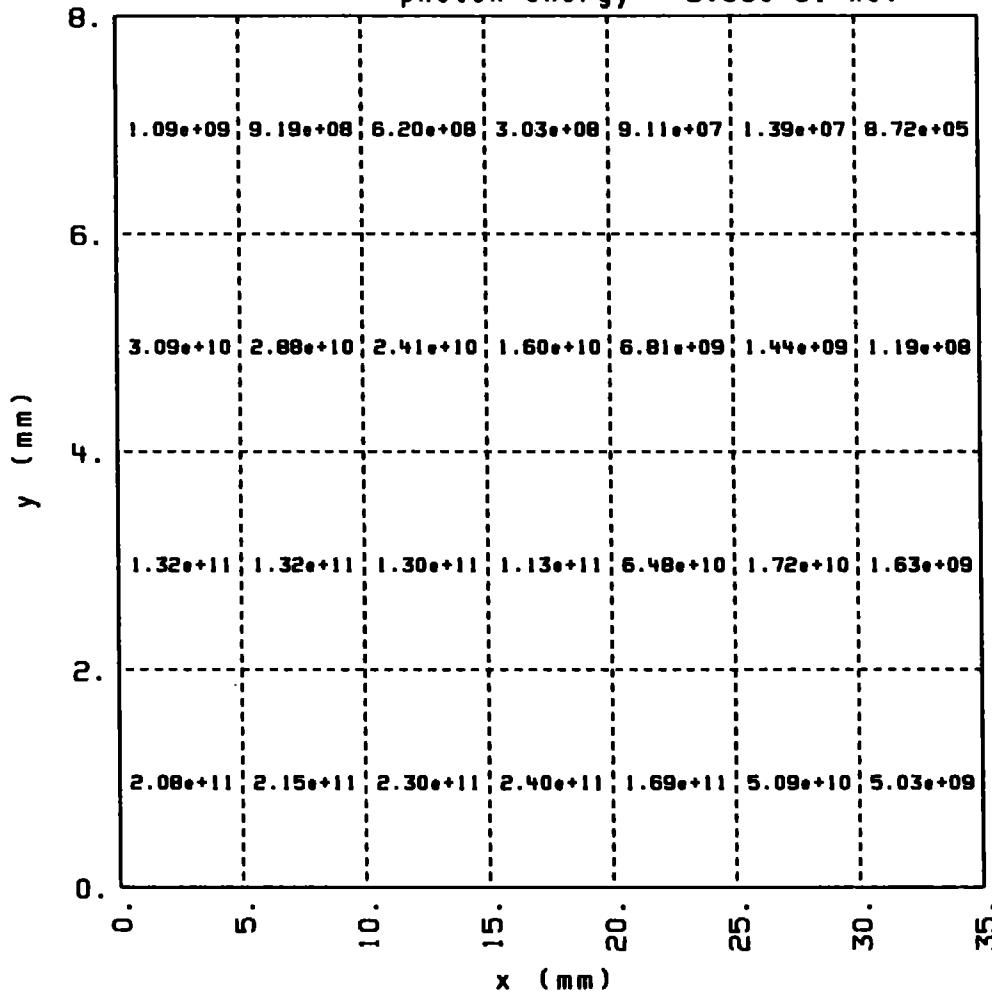
Table C5.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 5.00e-01 keV



parallel
polarization

photons/sec/mA in 0.1% bandwidth

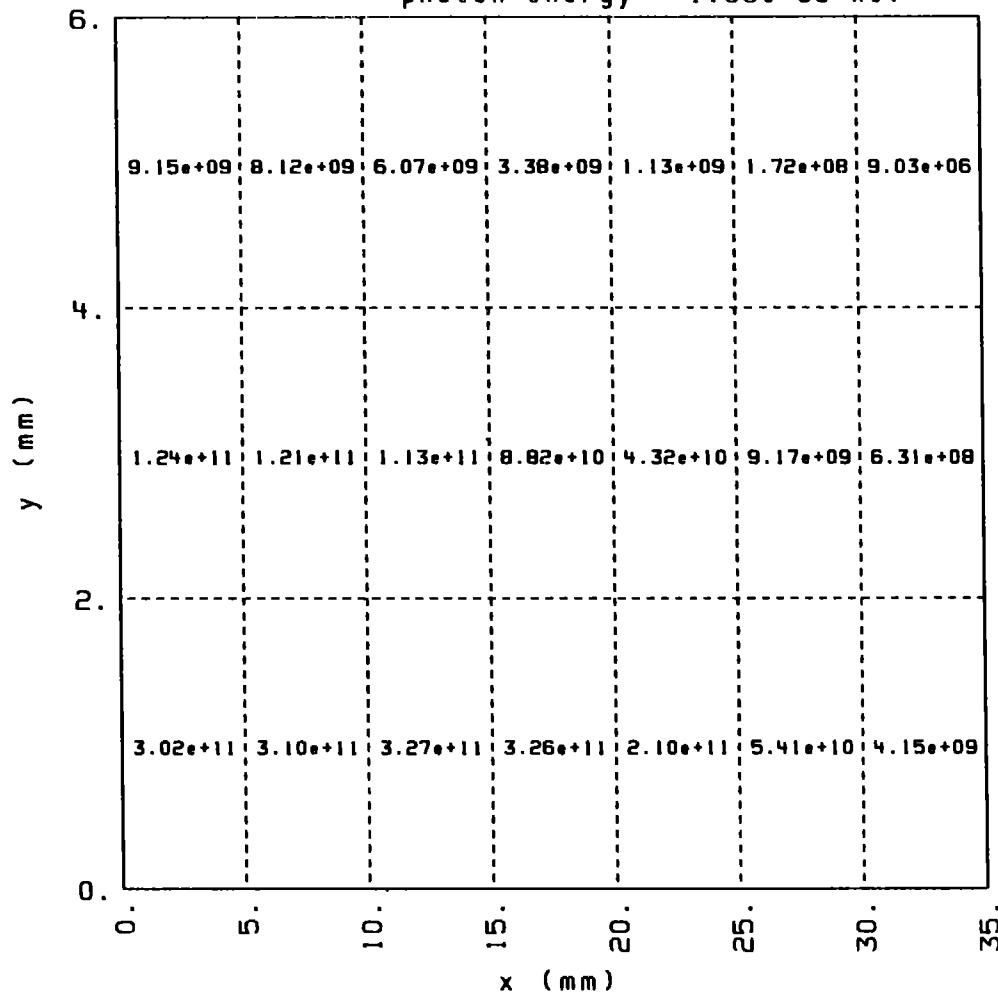
Table C5.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 1.00e+00 keV



parallel
polarization

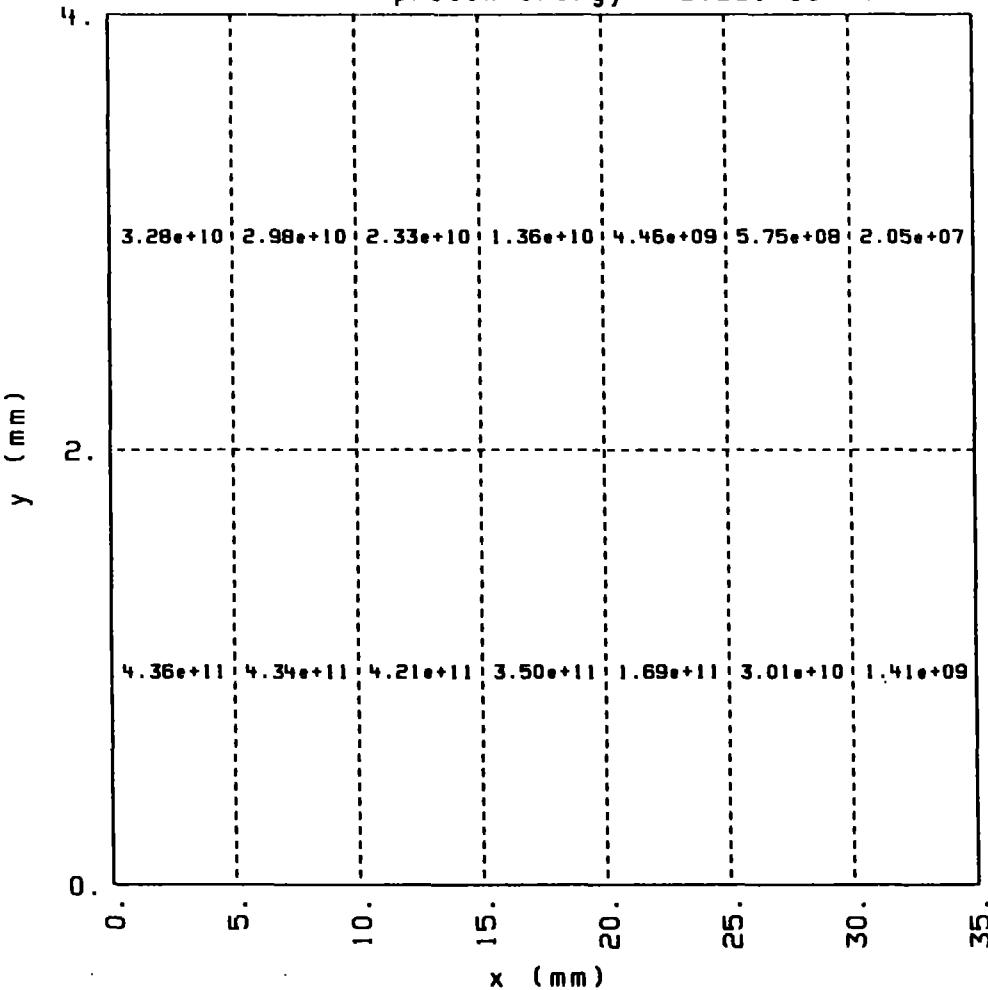
photons/sec/mA in 0.1% bandwidth

Table C5.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
 photon energy = $3.89e+00$ keV



parallel
polarization

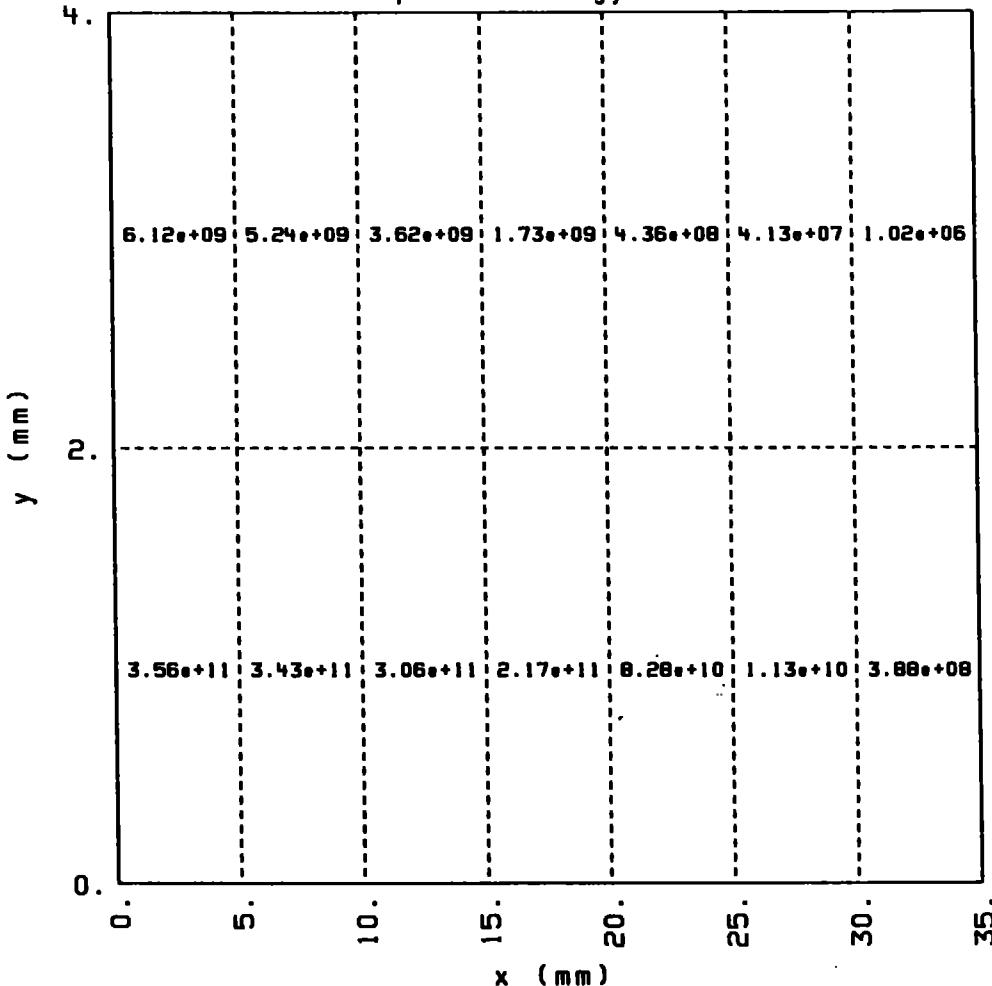
photons/sec/mA in 0.1% bandwidth

Table C5.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV
photon energy = 7.78e+00 keV



parallel
polarization

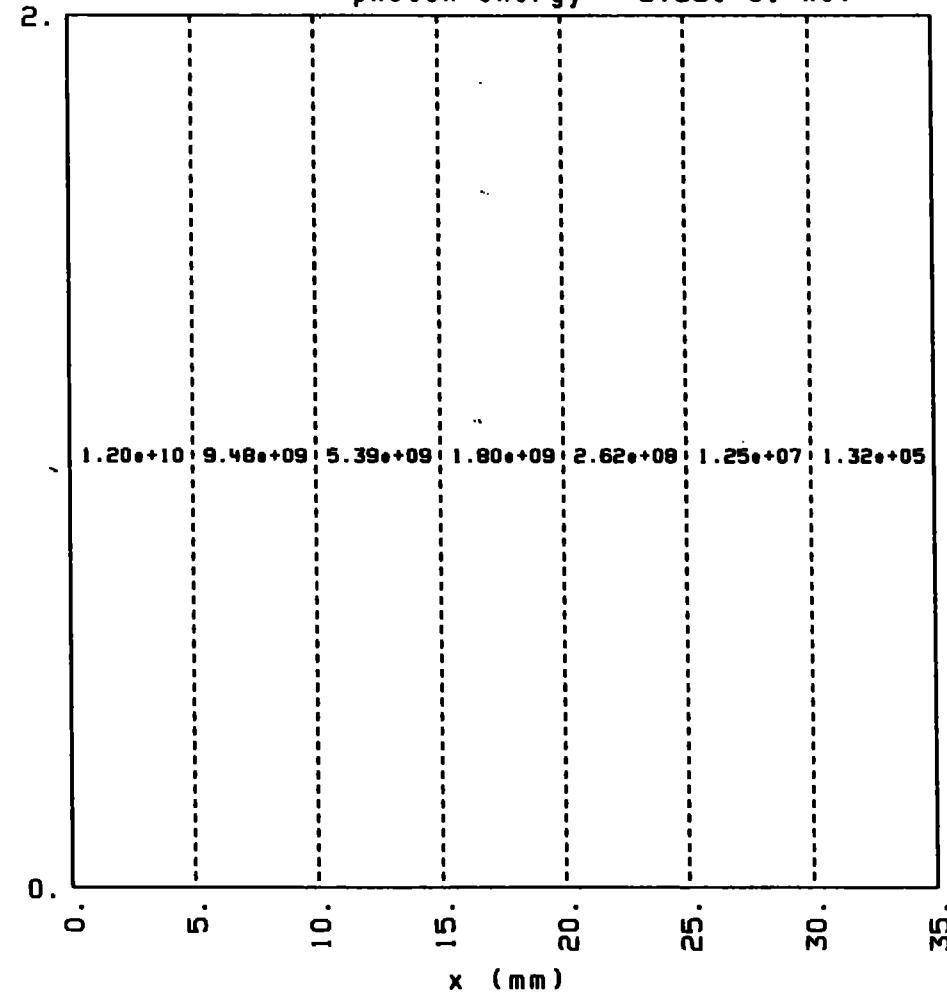
photons/sec/mA in 0.1% bandwidth

Table C5.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
photon energy = $3.89e+01$ keV



parallel
polarization

photons/sec/mA in 0.1% bandwidth

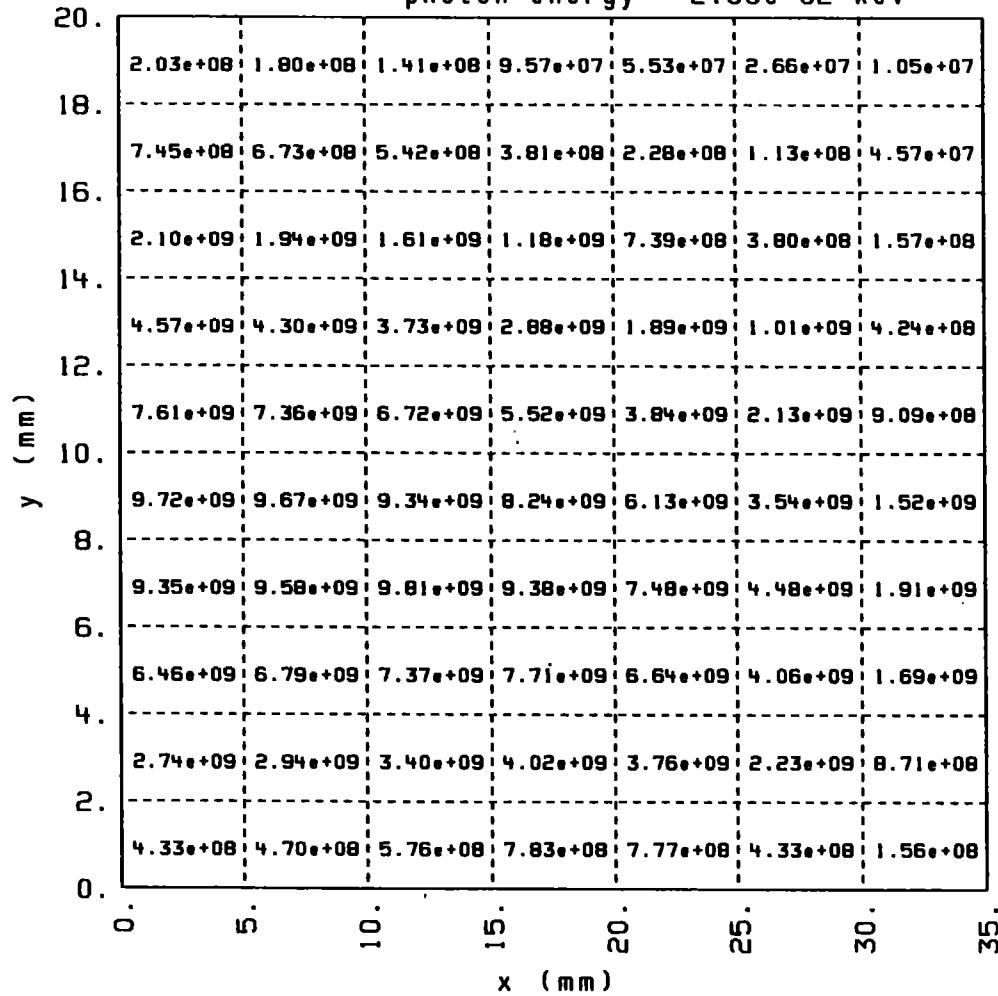
Table C6.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 2.00e-02 keV

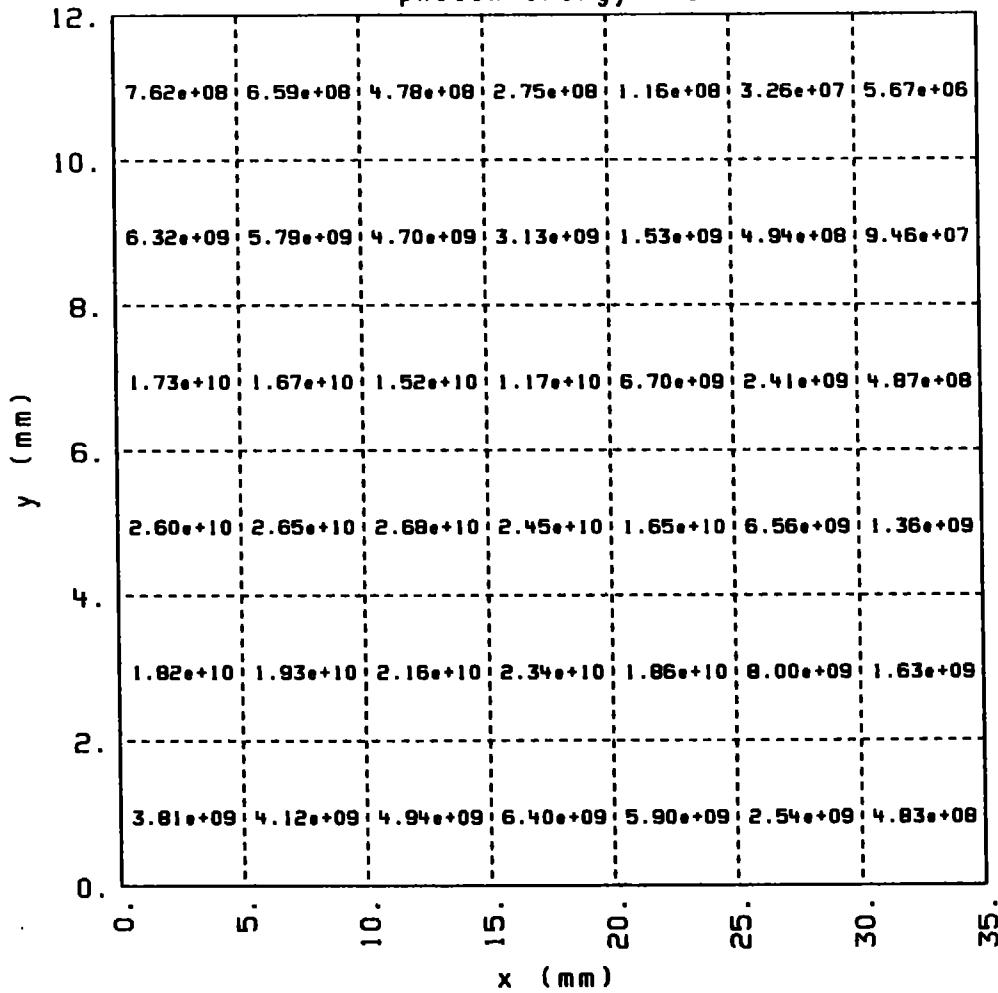
perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

Table C6.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
photon energy = $1.00e-01$ keVperpendicular
polarization

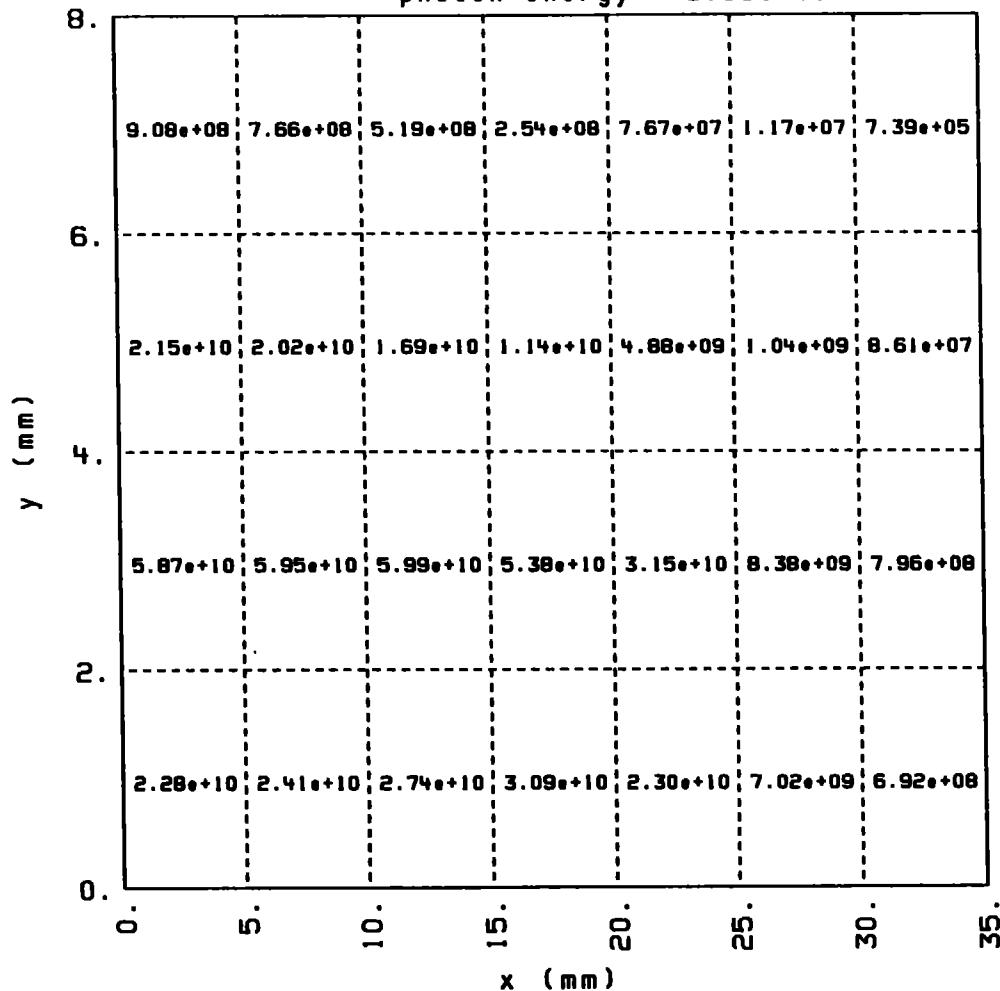
photons/sec/mA in 0.1% bandwidth

Table C6.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.00e+00$ GeV critical energy = $7.78e+00$ keV
photon energy = $5.00e-01$ keV



perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

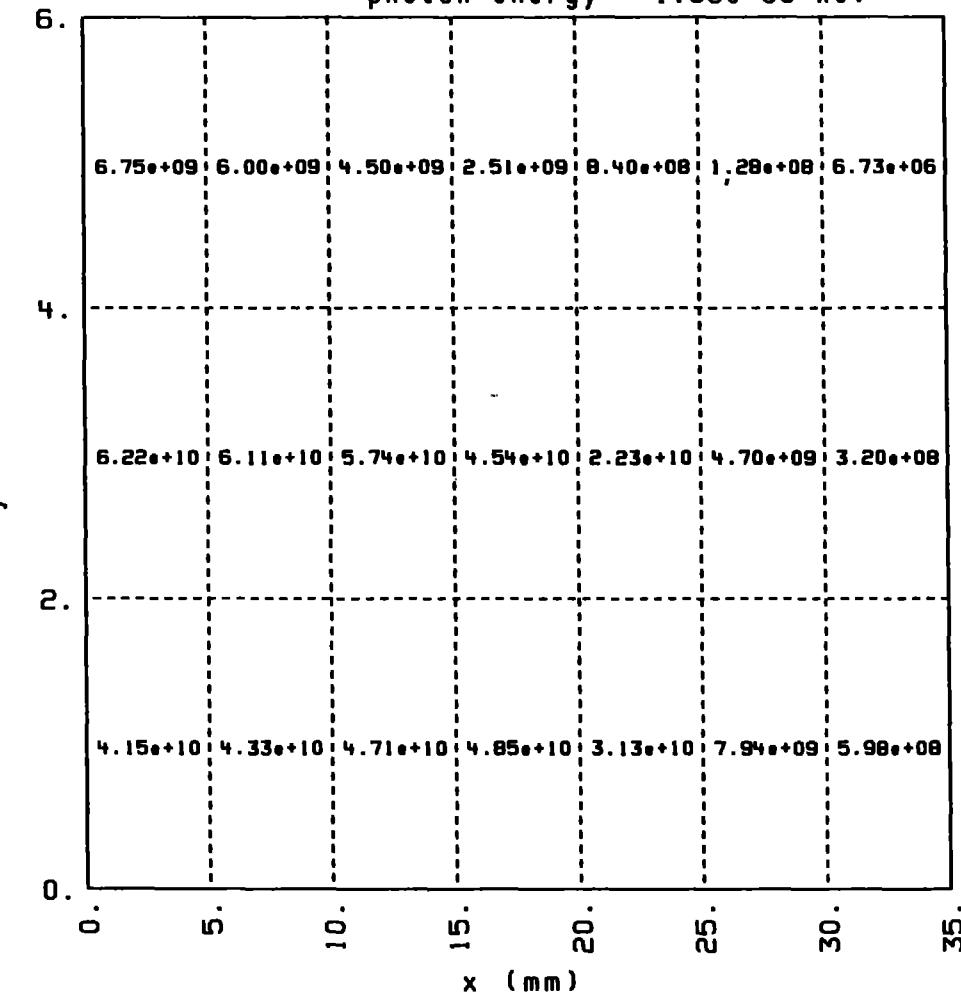
Table C6.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 1.00e+00 keV

perpendicular
polarization

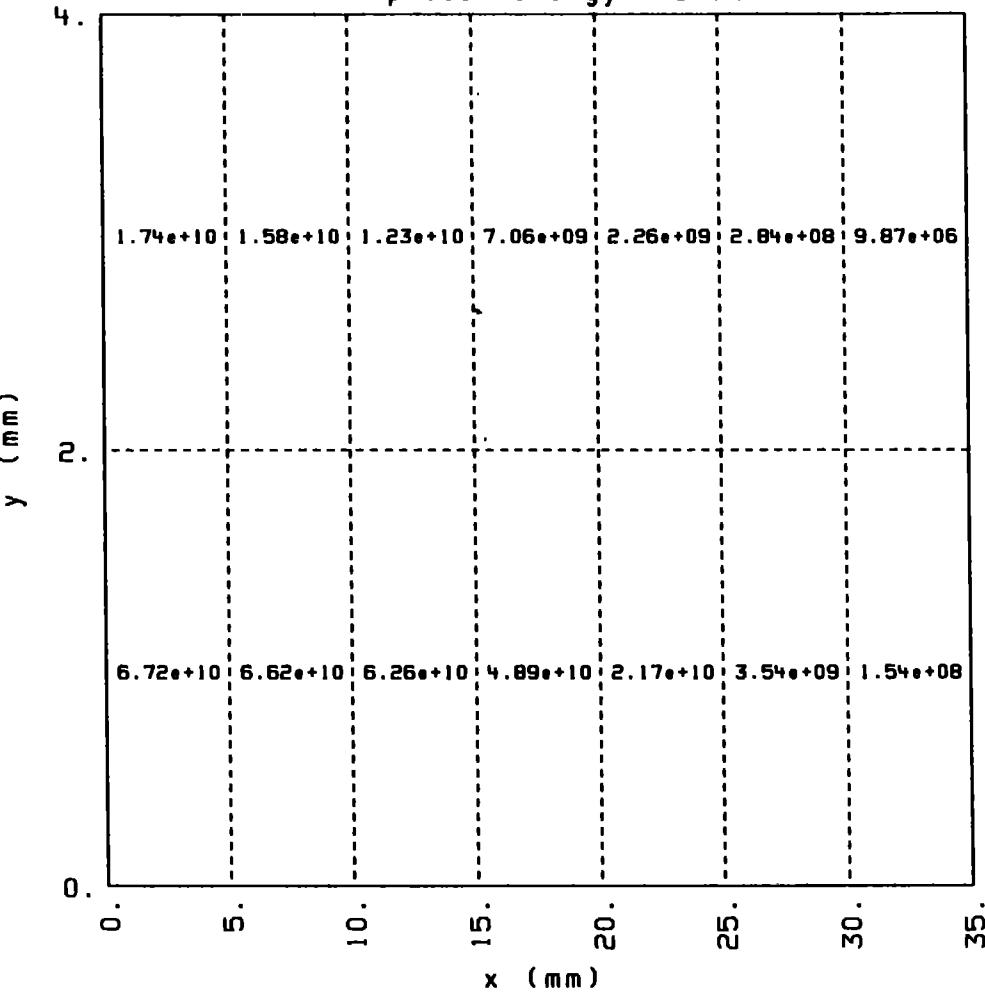
photons/sec/mA in 0.1% bandwidth

Table C6.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV
 photon energy = 3.89e+00 keV



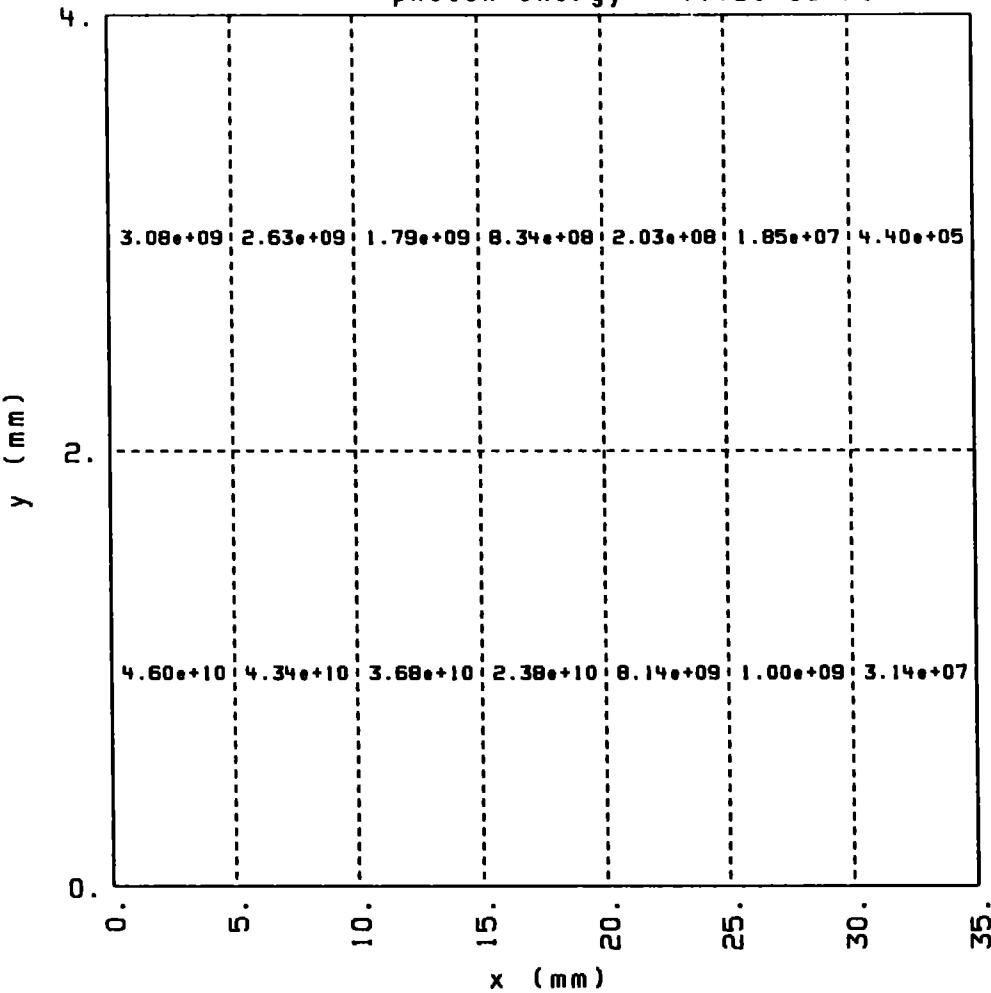
perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

Table C6.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV
photon energy = 7.78e+00 keVperpendicular
polarization

photons/sec/mA in 0.1% bandwidth

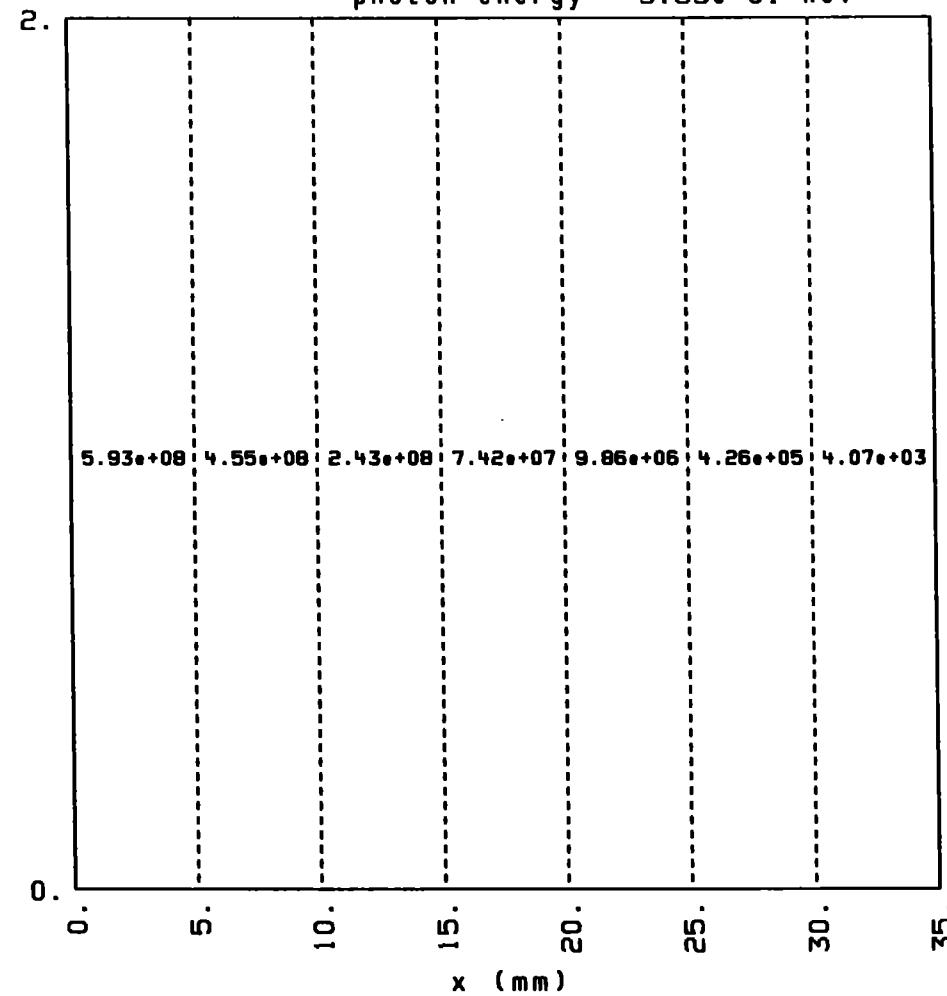
Table C6.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = 3.00e+00 GeV critical energy = 7.78e+00 keV

photon energy = 3.89e+01 keV



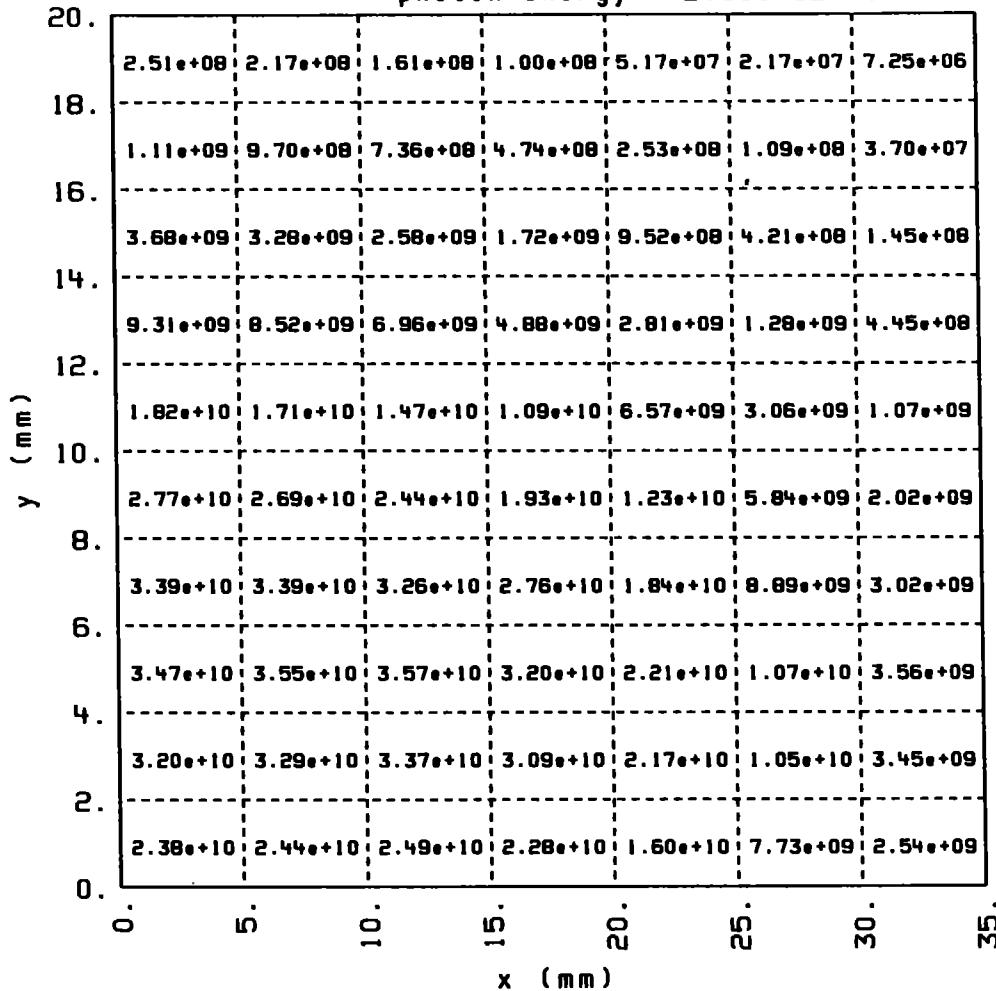
perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

Table C7.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

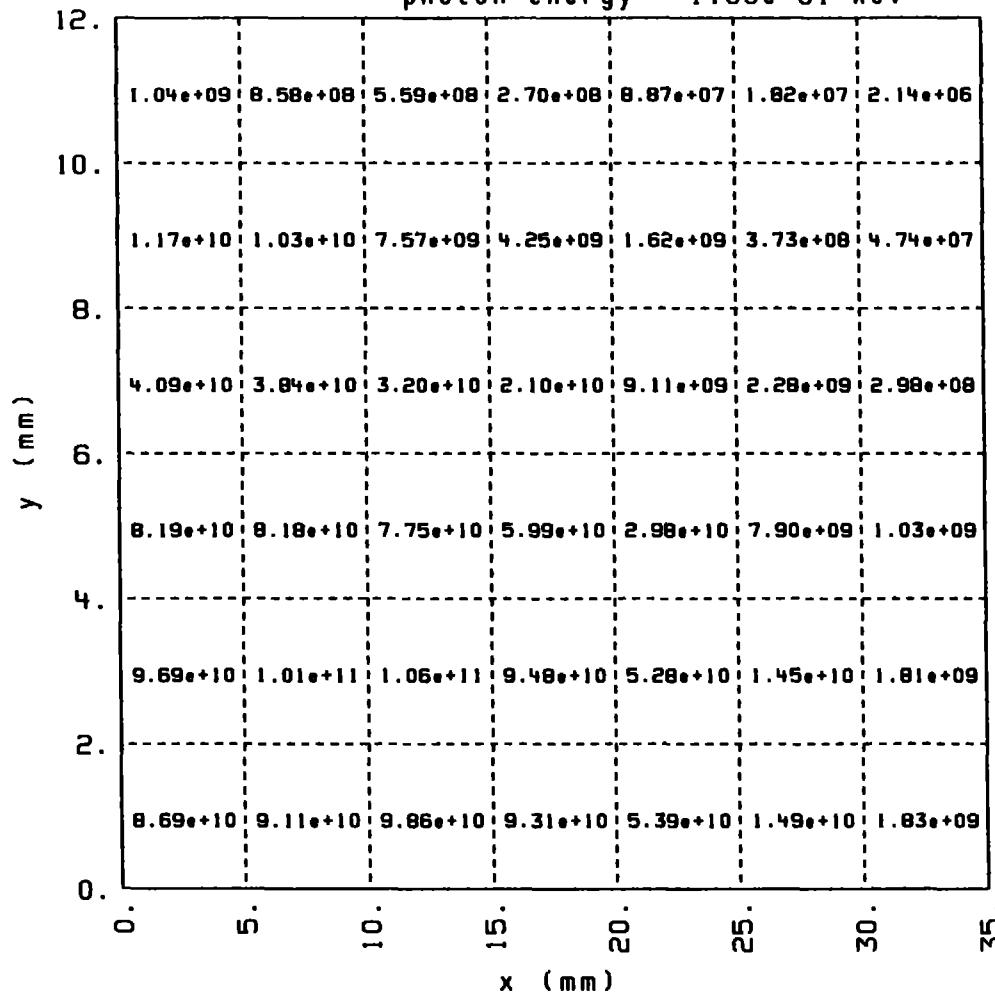
electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $2.00e-02$ keV

photons/sec/mA in 0.1% bandwidth

Table C7.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keVphoton energy = $1.00e-01$ keV

photons/sec/mA in 0.1% bandwidth

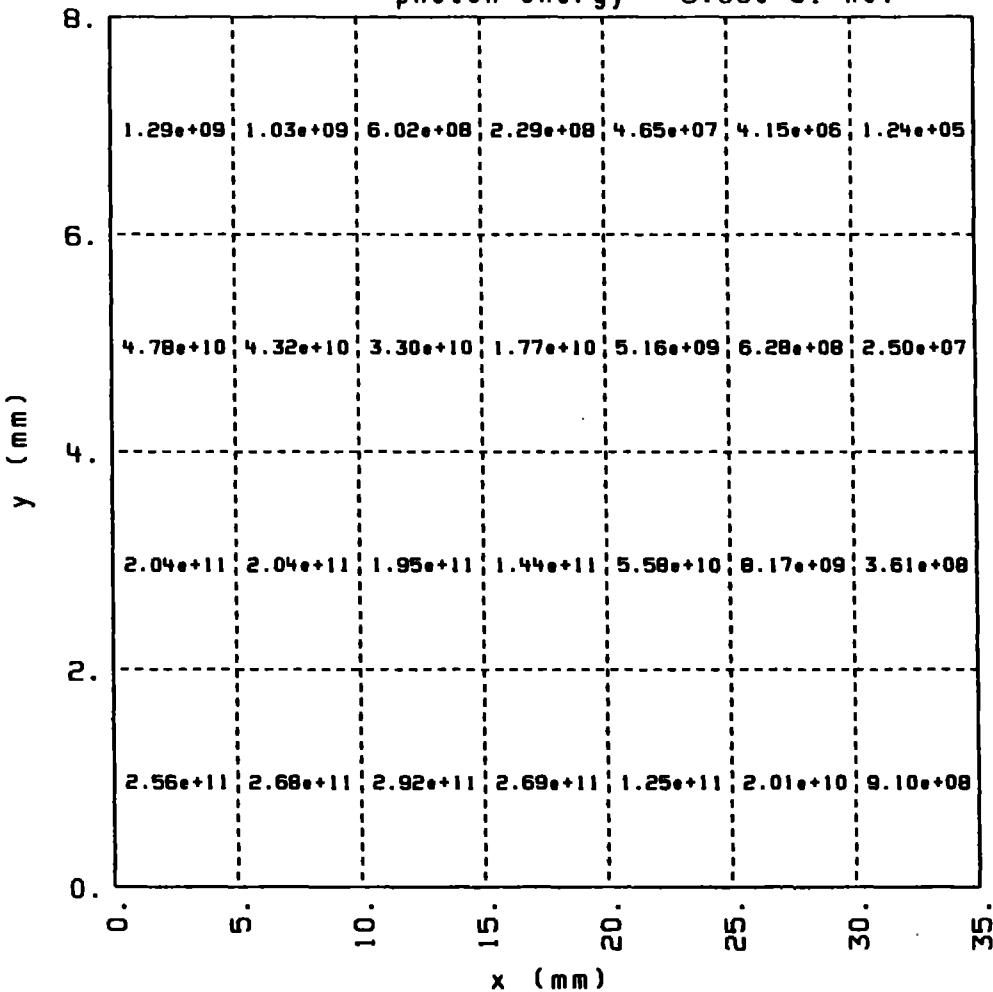
Table C7.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV

photon energy = $5.00e-01$ keV



photons/sec/mA in 0.1% bandwidth

Table C7.4.

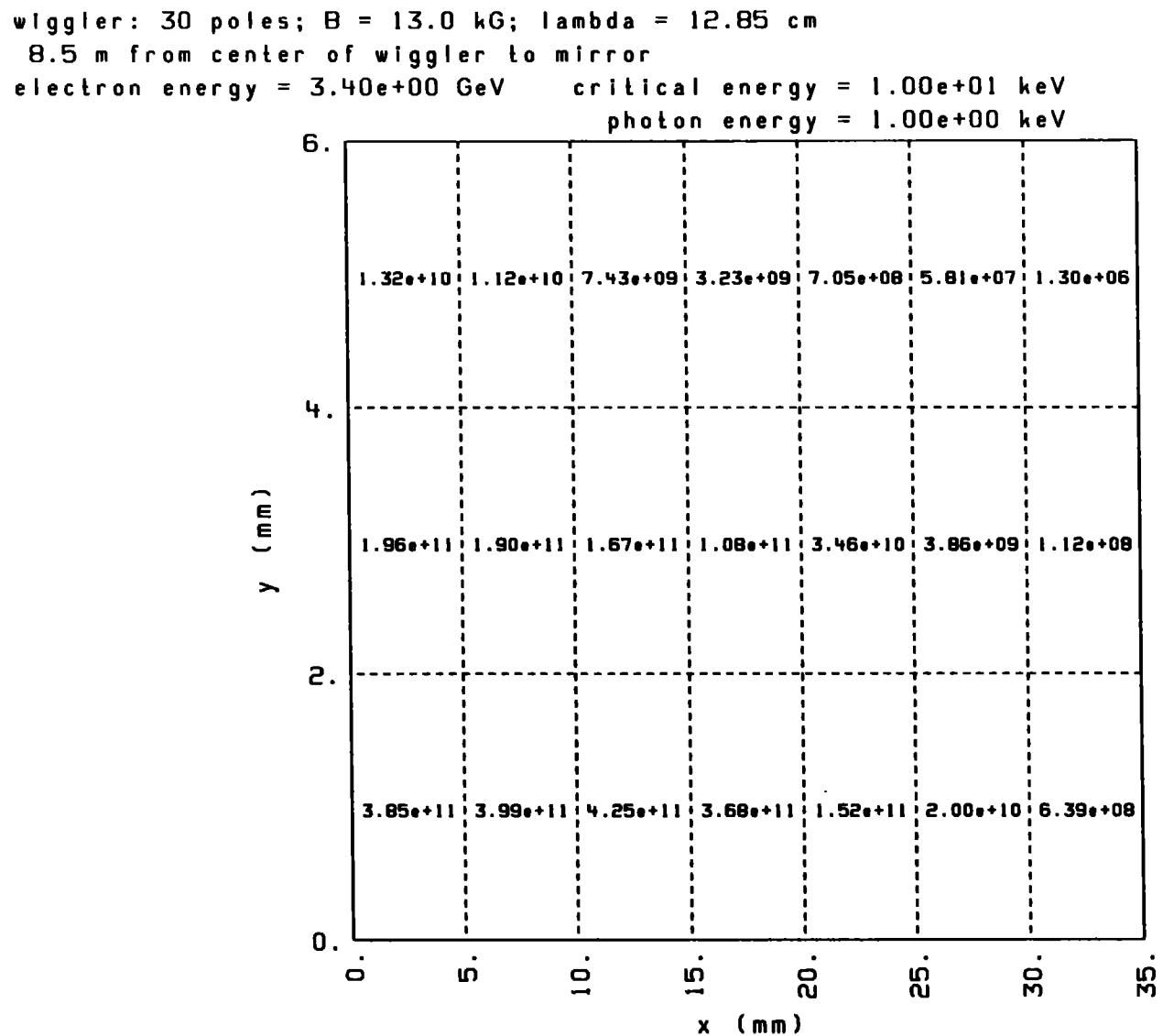


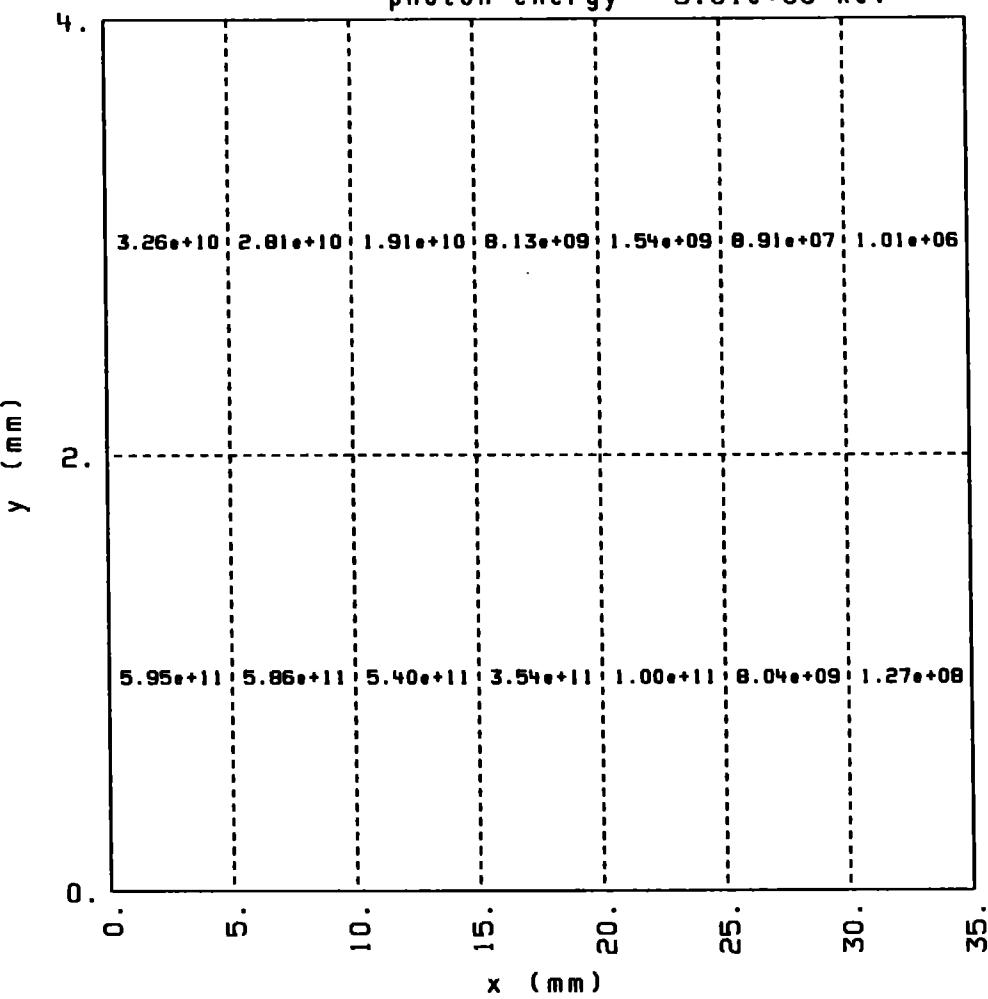
Table C7.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV

photon energy = $5.01e+00$ keV



photons/sec/mA in 0.1% bandwidth

Table C7.6.

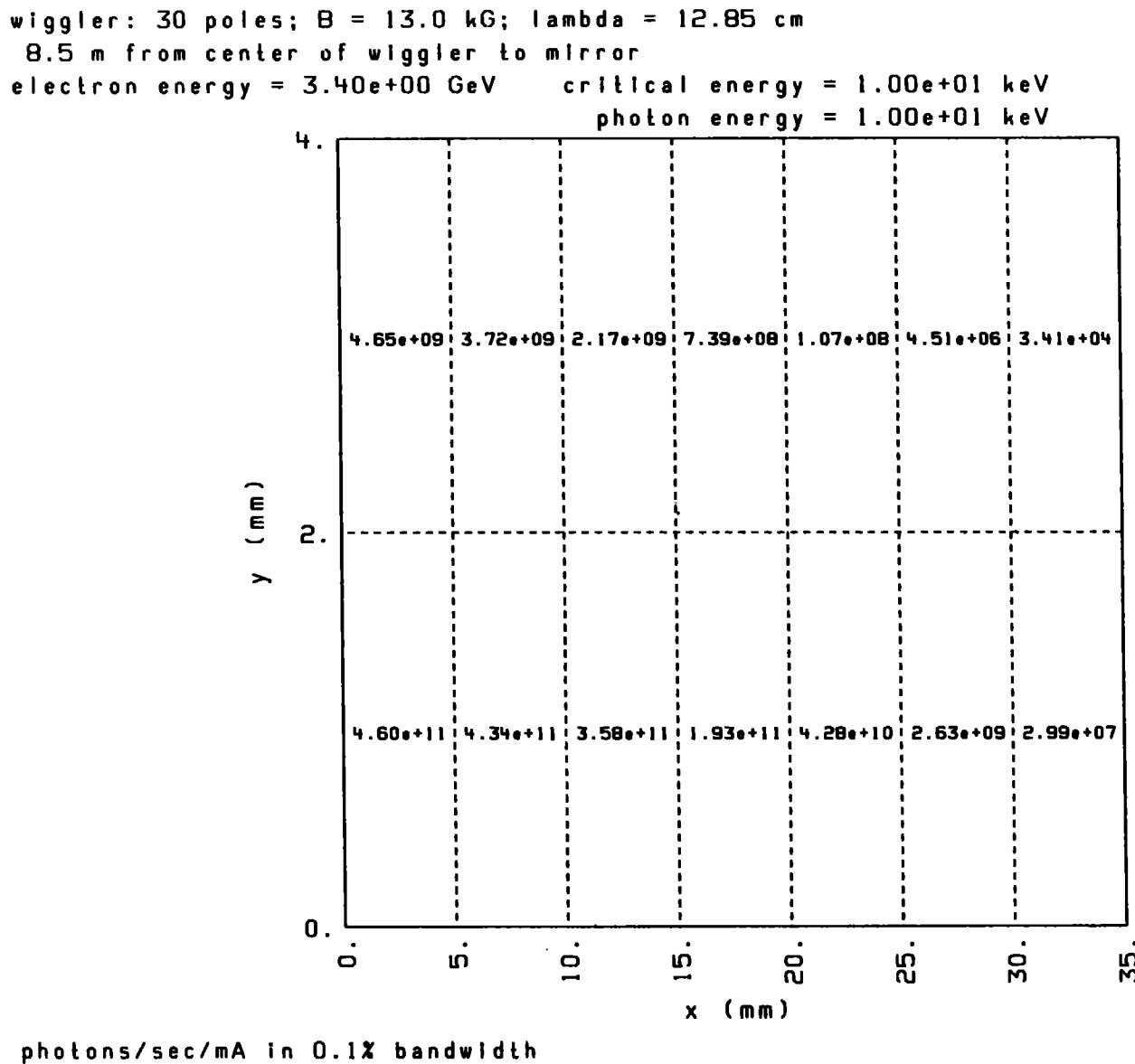
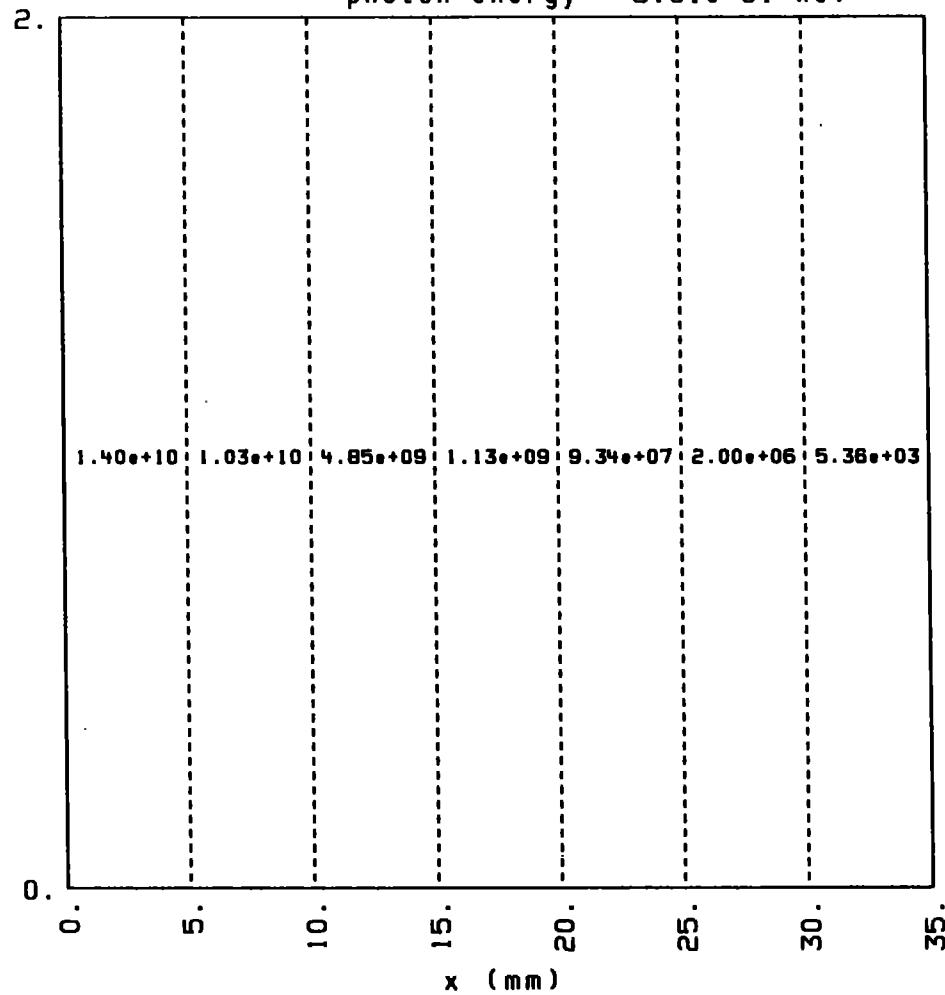


Table C7.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $5.01e+01$ keV

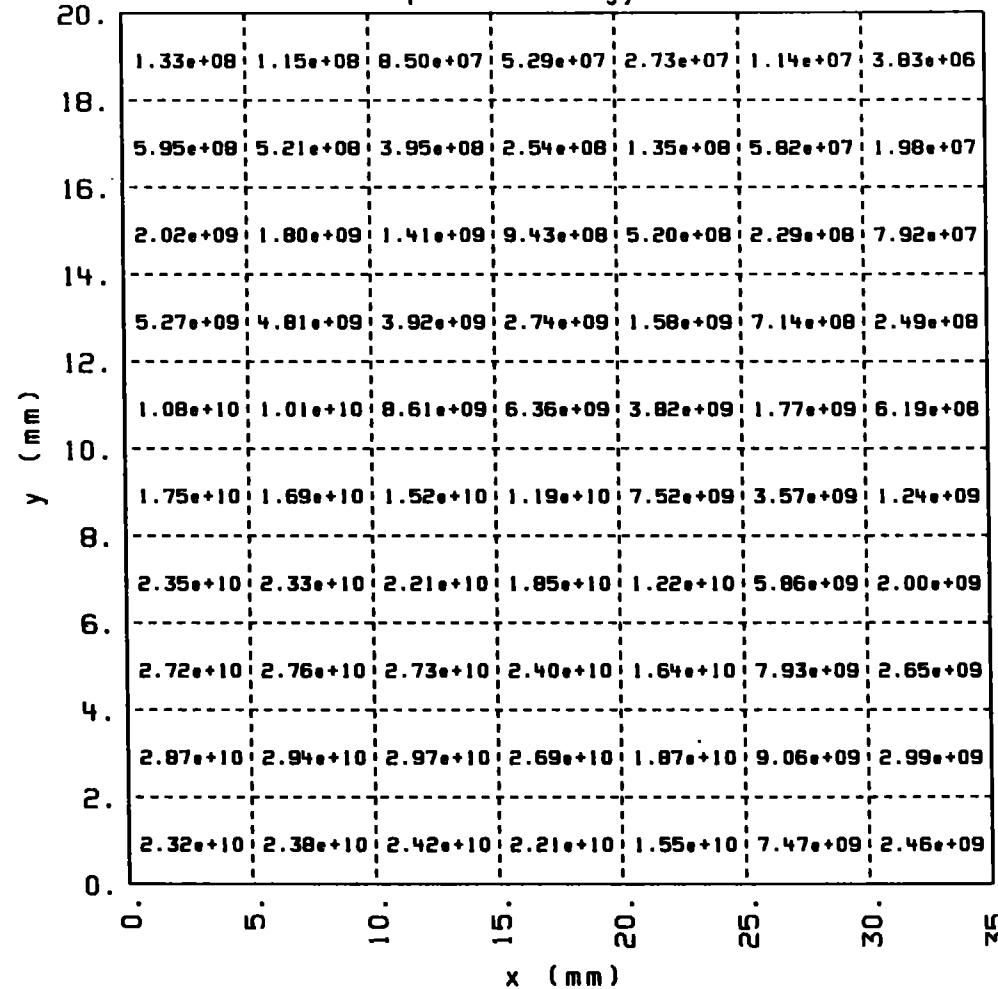


photons/sec/mA in 0.1% bandwidth

Table C8.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

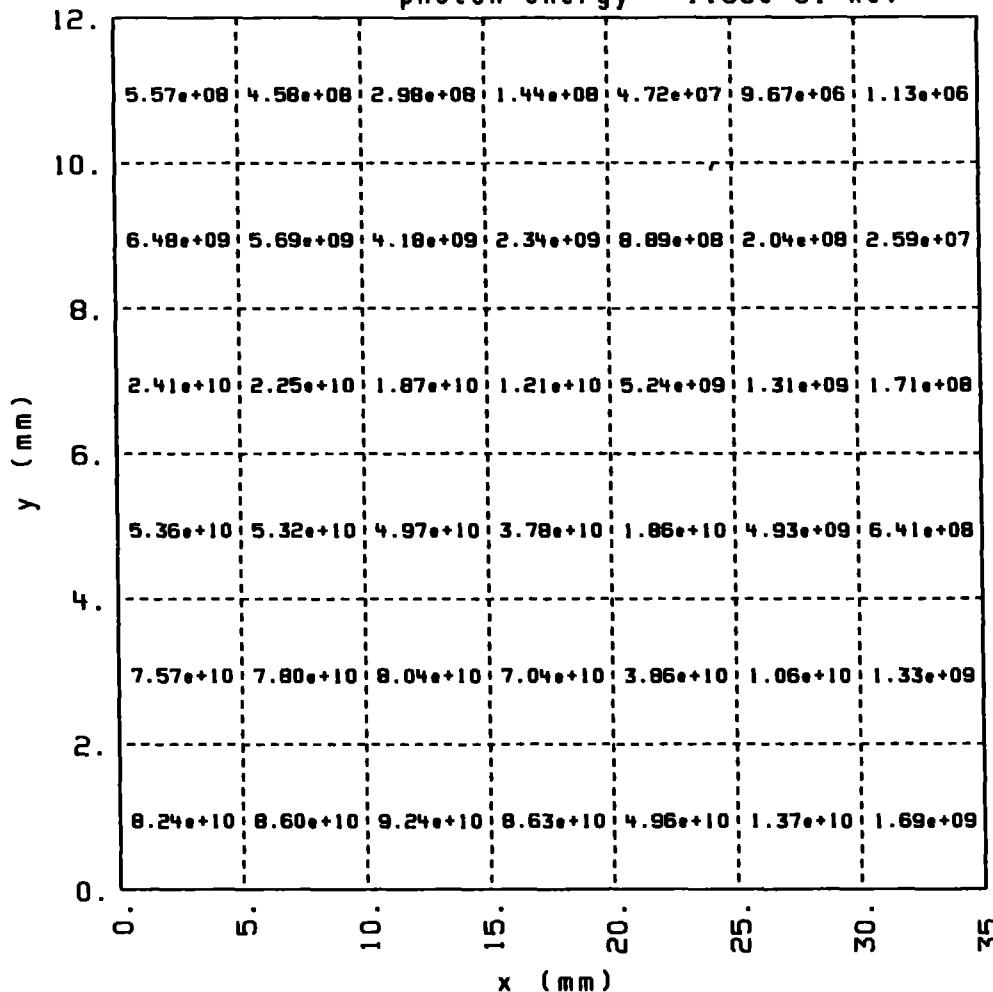
electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $2.00e-02$ keVparallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C8.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

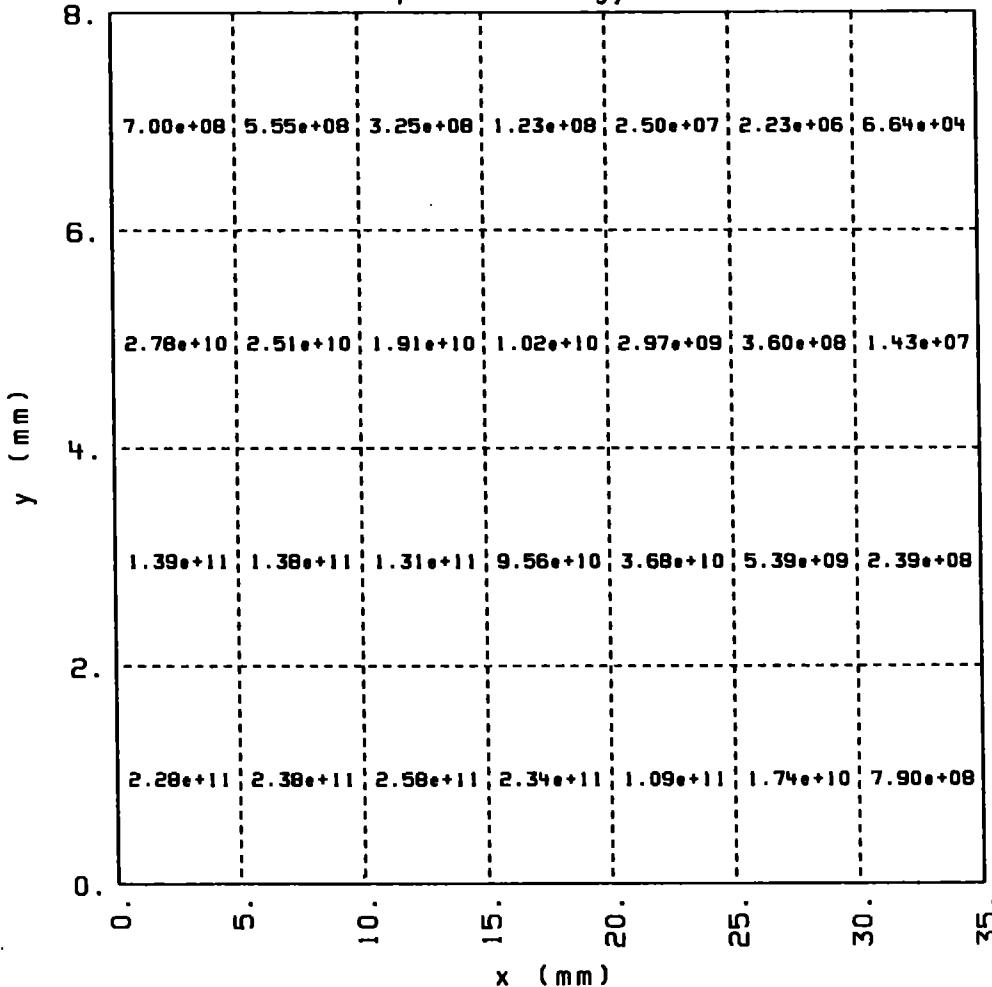
electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $1.00e-01$ keVparallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C8.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

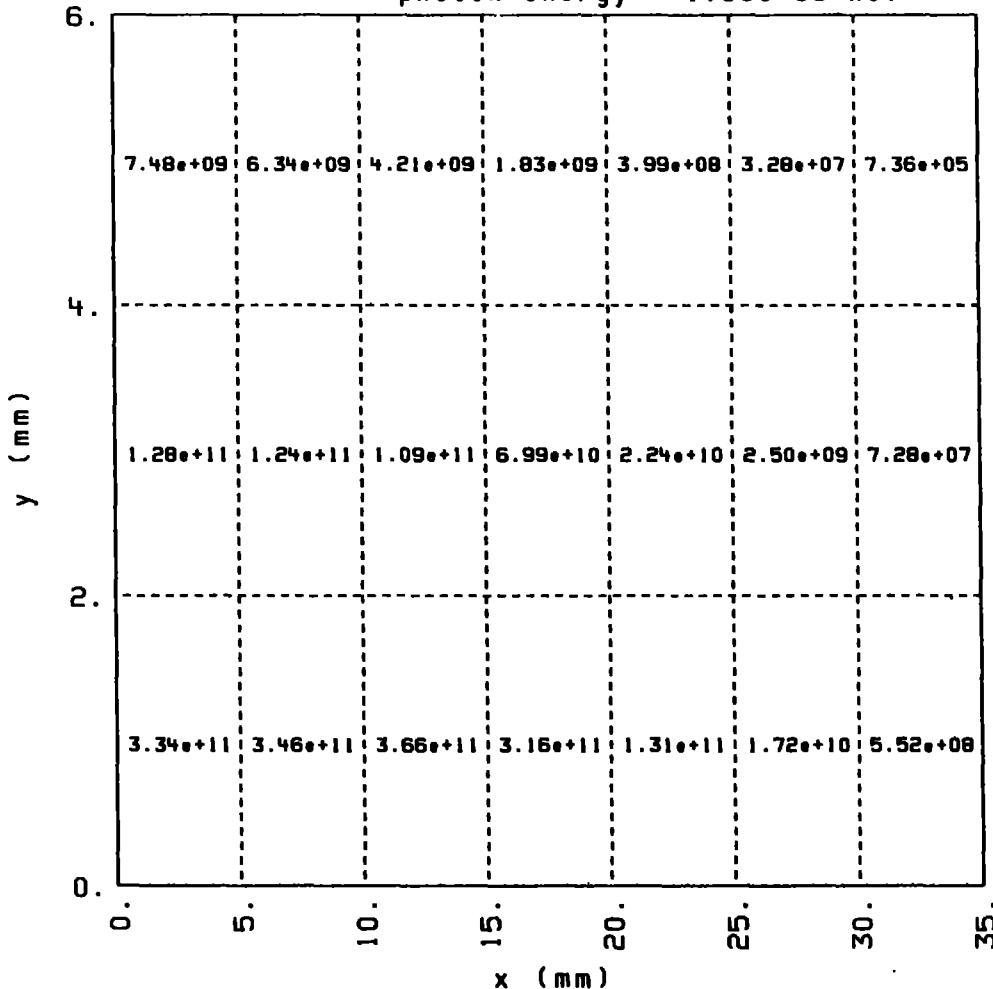
electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $5.00e-01$ keVparallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C8.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keVphoton energy = $1.00e+00$ keV

parallel
polarization

photons/sec/mA in 0.1% bandwidth

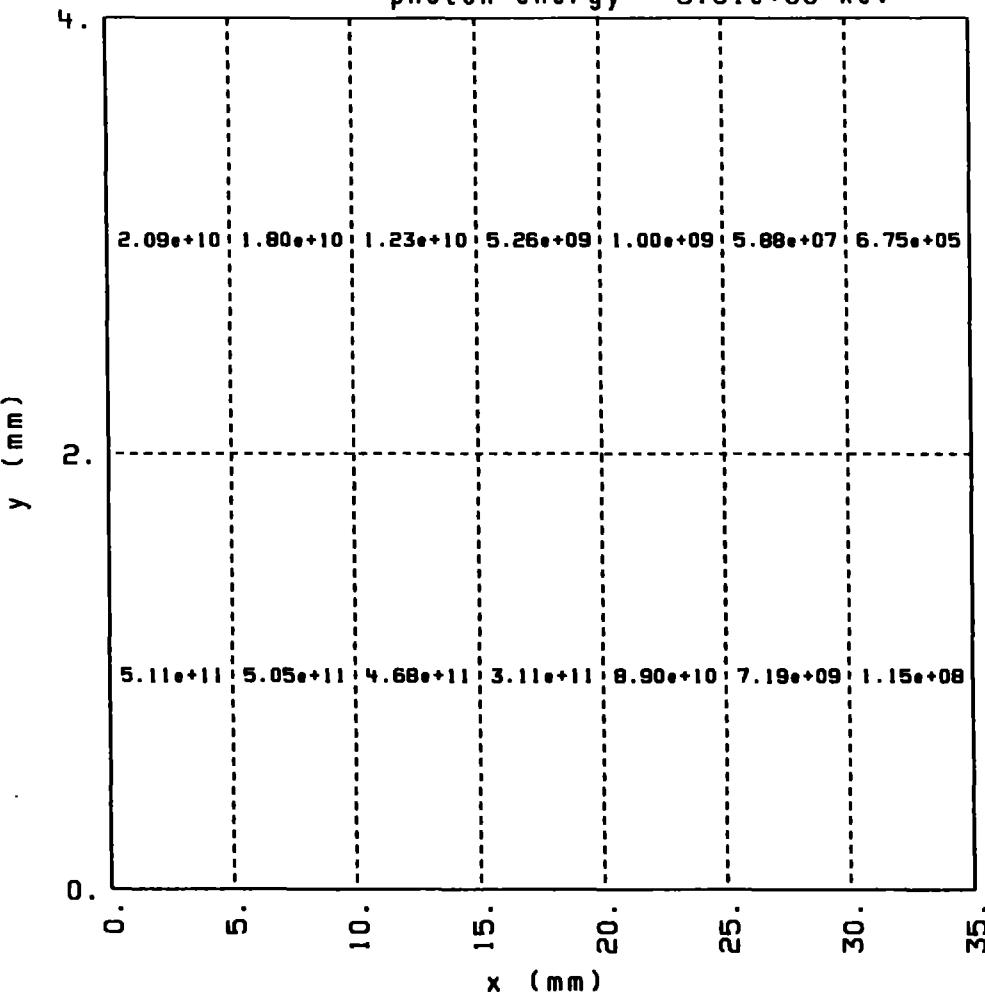
Table C8.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV

photon energy = $5.01e+00$ keV



parallel
polarization

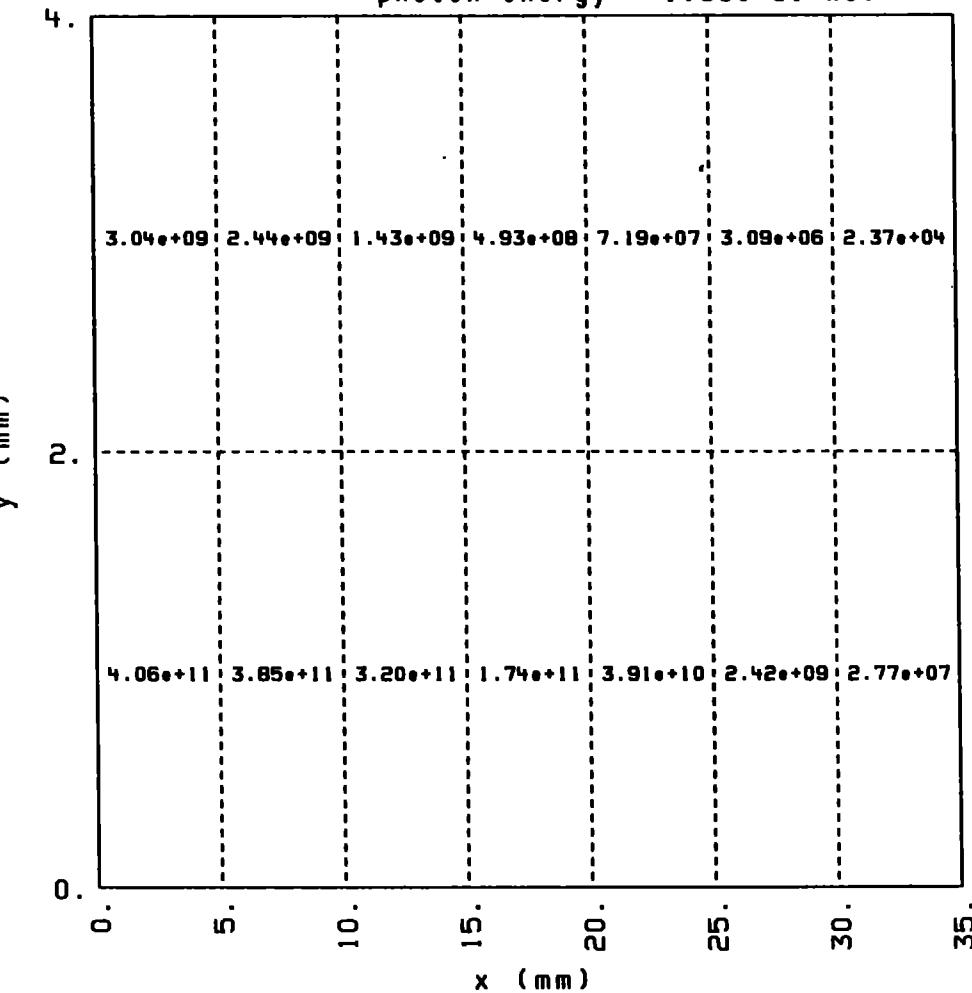
photons/sec/mA in 0.1% bandwidth

Table C8.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e+01$ keV



parallel
polarization

photons/sec/mA in 0.1% bandwidth

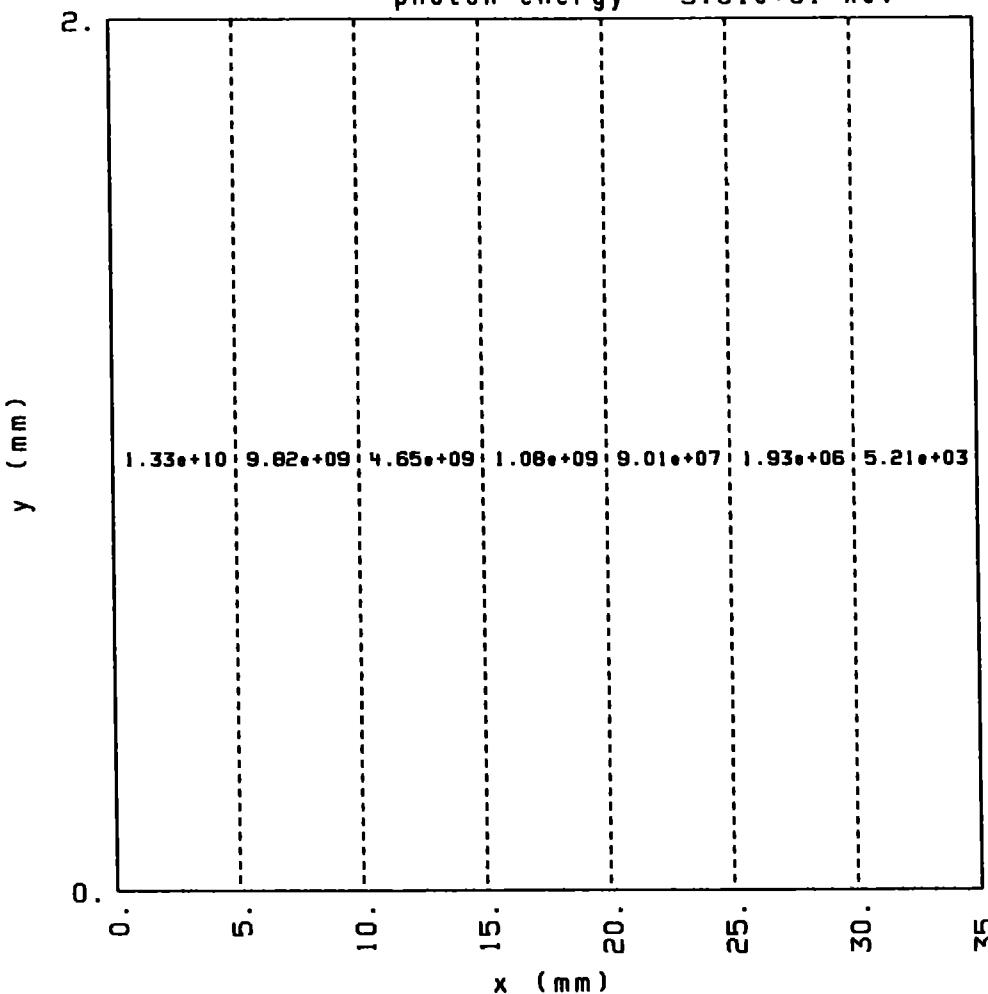
Table C8.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV

photon energy = $5.01e+01$ keV



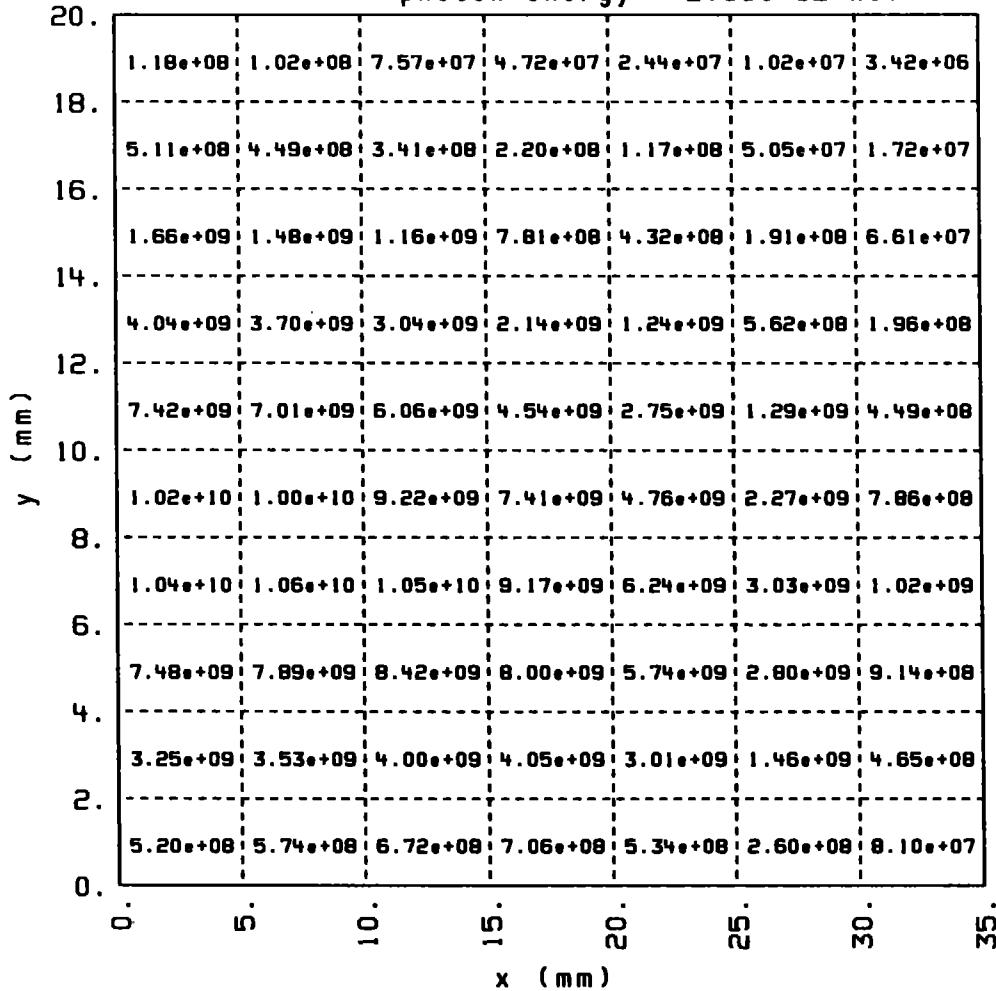
parallel
polarization

photons/sec/mA in 0.1% bandwidth

Table C9.1.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

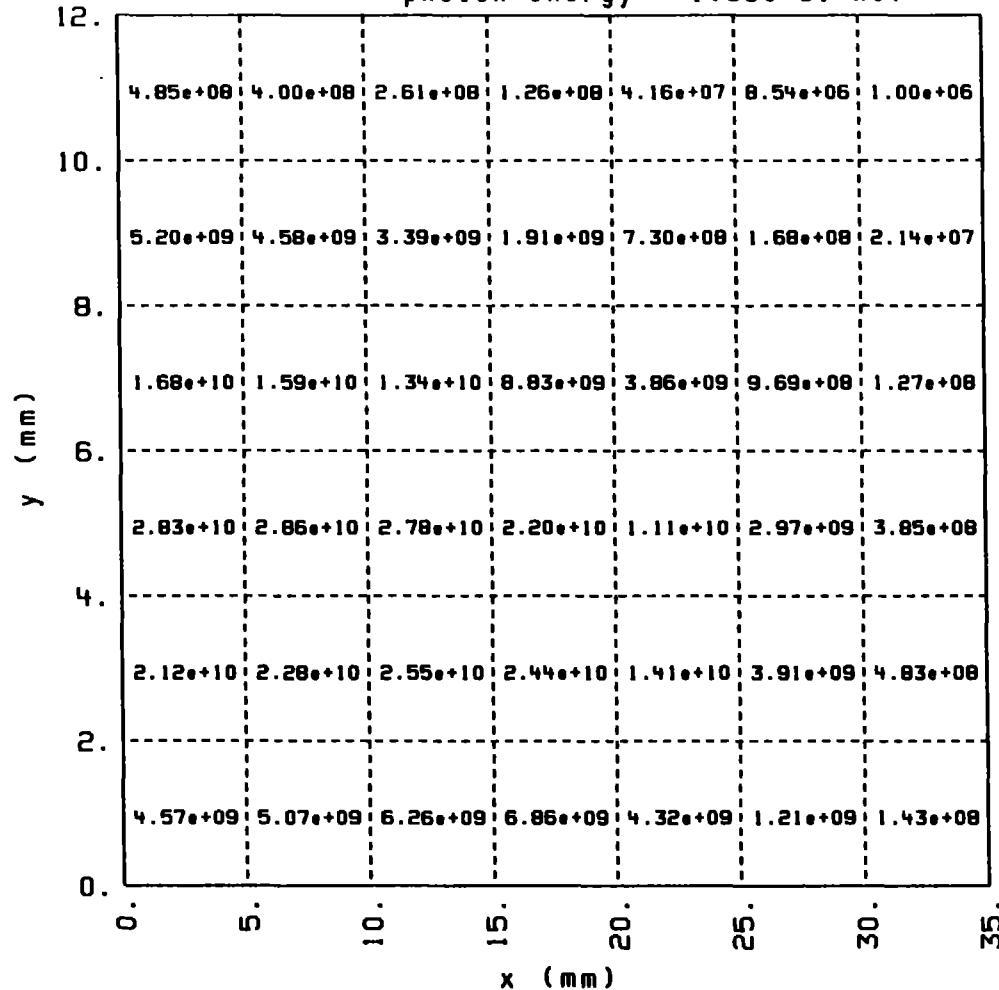
electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $2.00e-02$ keVperpendicular
polarization

photons/sec/mA in 0.1% bandwidth

Table C9.2.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $1.00e-01$ keVperpendicular
polarization

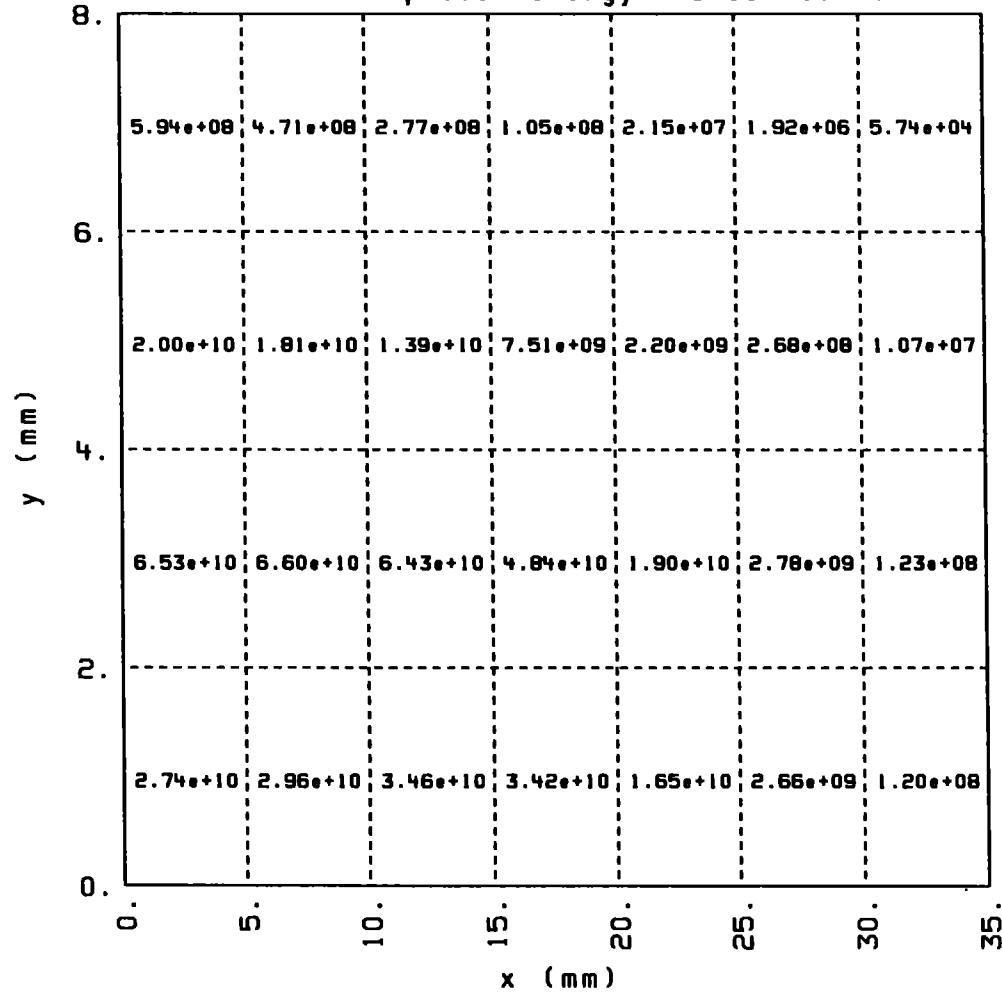
photons/sec/mA in 0.1% bandwidth

Table C9.3.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.00e-01$ keV



perpendicular
polarization

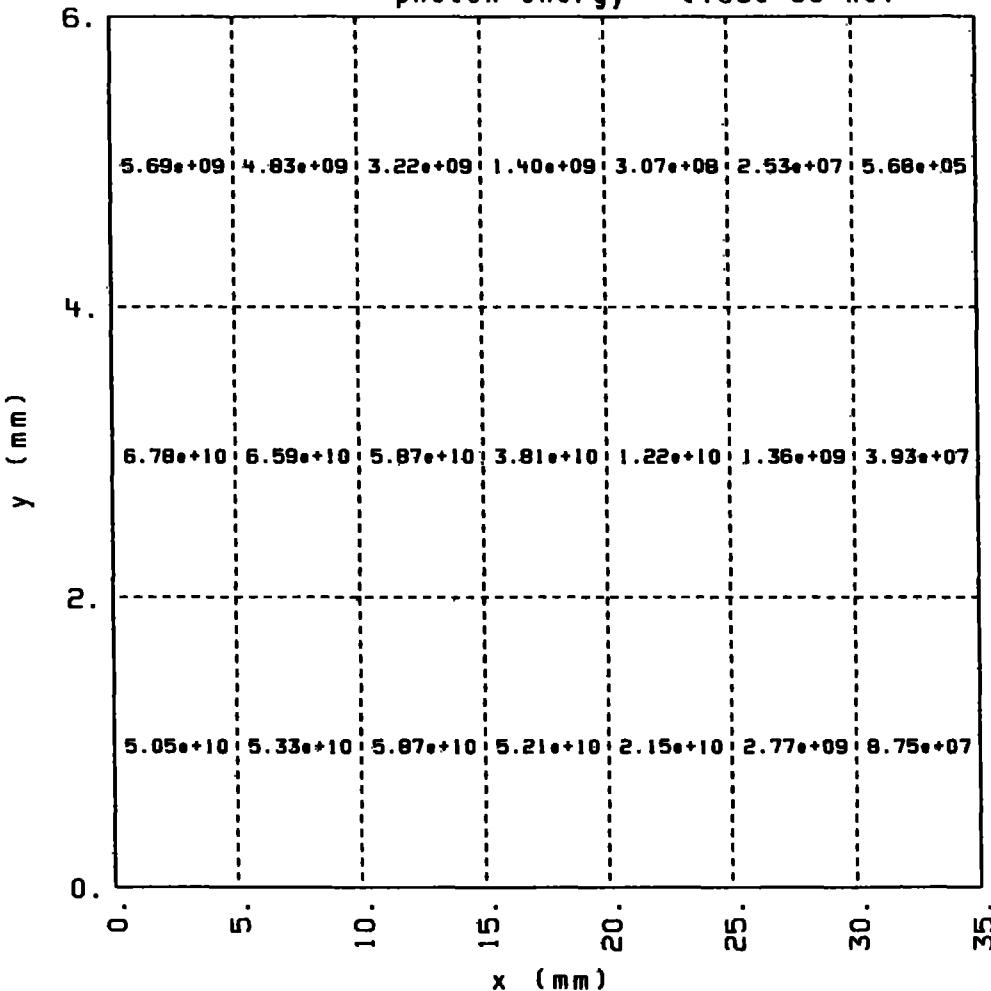
photons/sec/mA in 0.1% bandwidth

Table C9.4.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $1.00e+00$ keV



perpendicular
polarization

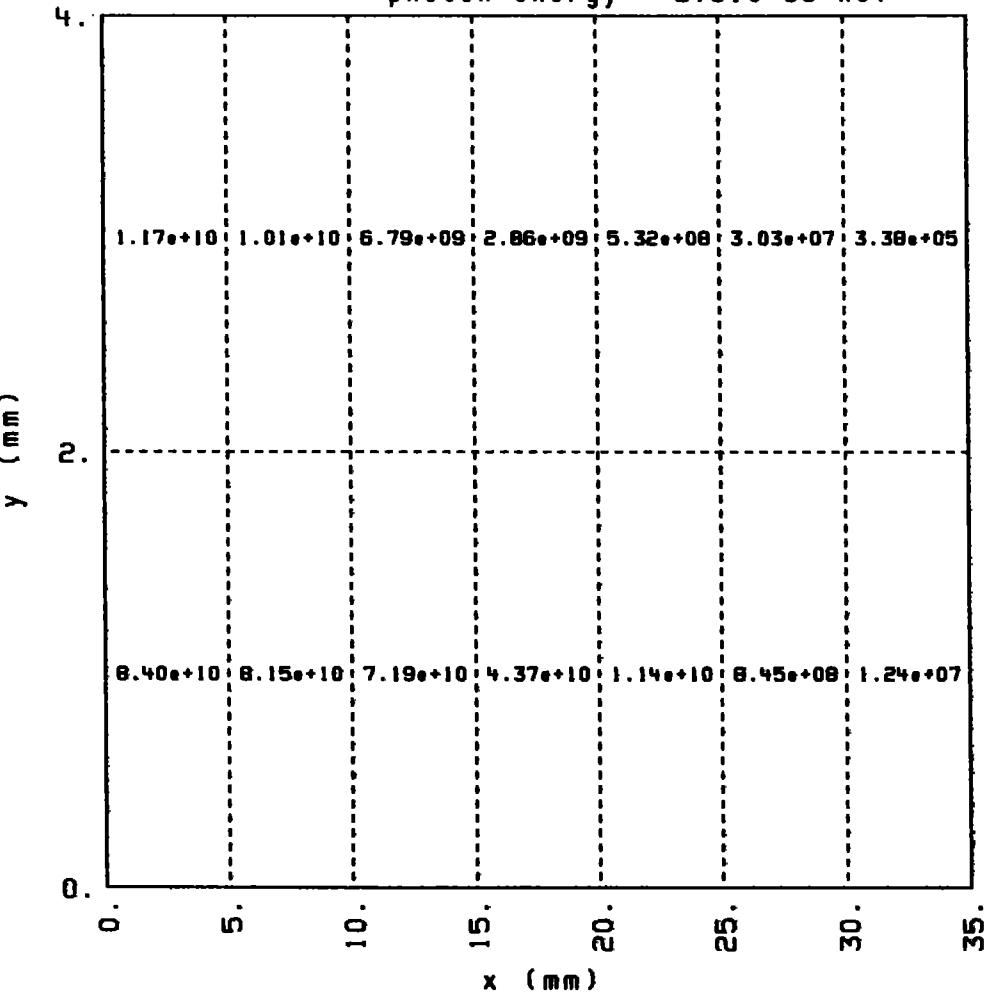
photons/sec/mA in 0.1% bandwidth

Table C9.5.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
 photon energy = $5.01e+00$ keV



perpendicular
polarization

photons/sec/mA in 0.1% bandwidth

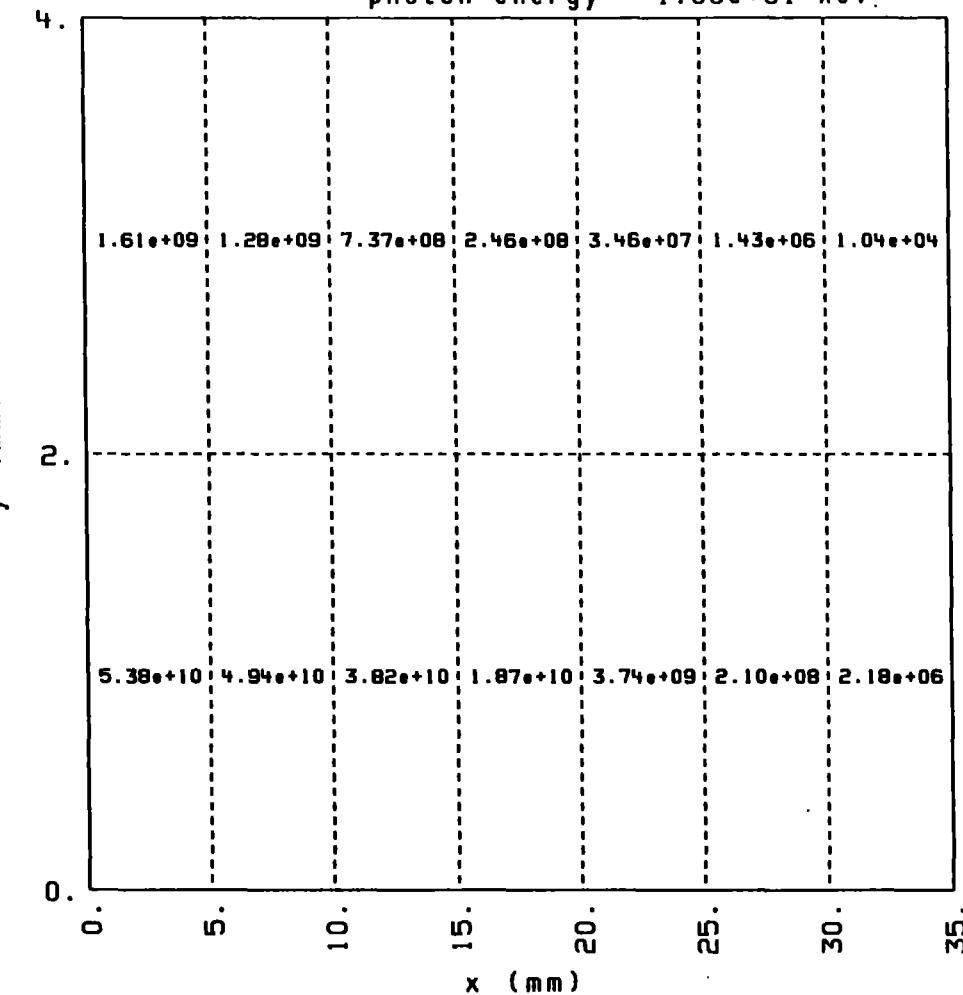
Table C9.6.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV

photon energy = $1.00e+01$ keV.



perpendicular
polarization

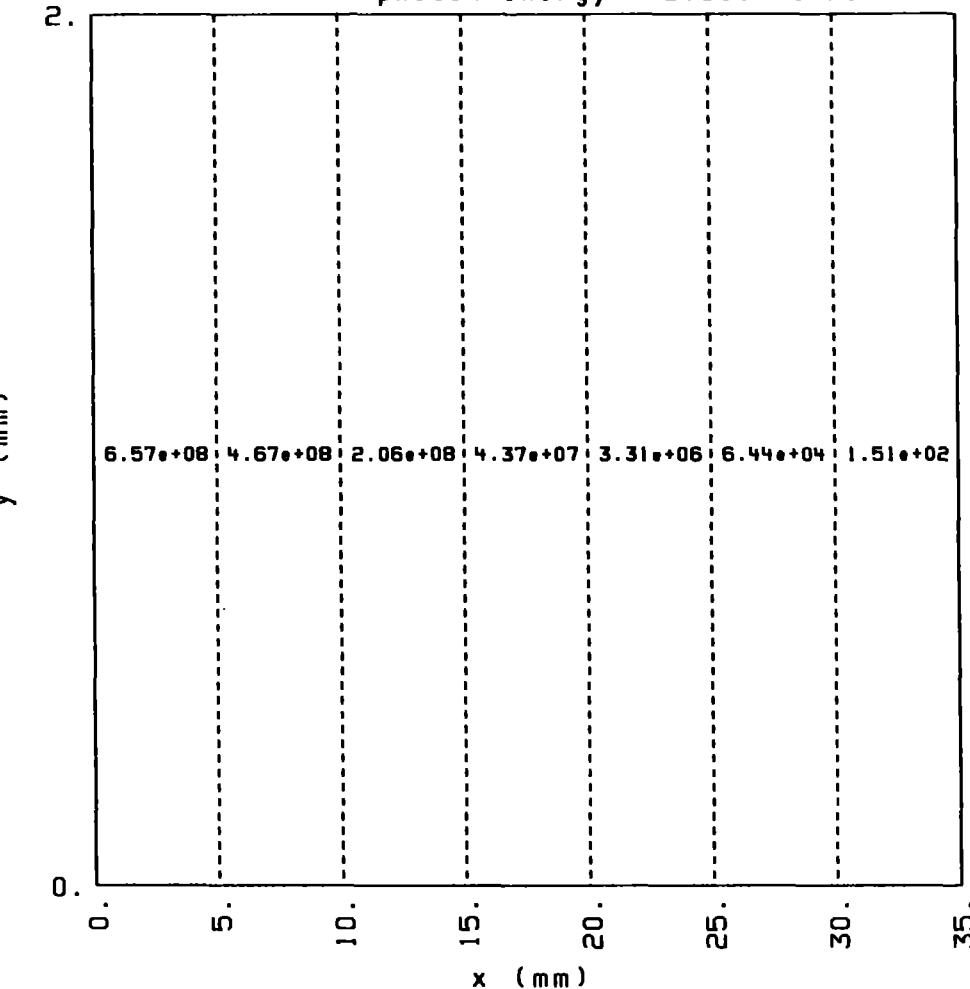
photons/sec/mm² in 0.1% bandwidth

Table C9.7.

wiggler: 30 poles; $B = 13.0$ kG; $\lambda = 12.85$ cm

8.5 m from center of wiggler to mirror

electron energy = $3.40e+00$ GeV critical energy = $1.00e+01$ keV
photon energy = $5.01e+01$ keV



perpendicular
polarization

photons/sec/mA in 0.1% bandwidth